

# NEW YORK-NEW JERSEY HARBOR AND TRIBUTARIES NEW YORK DISTRICT

Interim Report Plan Formulation Appendix

## *Contents*

*Factsheets for Assumed Projects (Economics Modeling)*

*Table of Existing Projects by Other Agencies*



**US Army Corps  
of Engineers®**



**Department of  
Environmental  
Conservation**

**NYC**  
Mayor's Office of  
Recovery & Resiliency

## Future Without Project Assumptions

In the future without project condition (FWOPC), it is anticipated that the study area will continue to experience damages from coastal storms, and that the damages may increase as a result of more intense storm events. For this initial round of plan formulation, the decision was made to compare the alternatives using a present worth analysis (due to the complexities of comparing features with a wide range of implementation timeframes). Effectively, the base year has not yet been established. Without project damages from 2030 to 2100 have been calculated at this time, with the period of analysis (over 50 years, starting when the last feature of the initial construction elements of recommended plan become operational) to be identified for the upcoming draft report. The planning horizon, which is a 100 year period to account for the effects of relative sea level change, has been identified as 2022-2122 (starting from the conclusion of this study).

Another consideration for the FWOPC is the numerous recovery efforts and resiliency improvements to address CSRM in the study area. As part of a federal agency collaborative effort, these efforts are tracked in a database detailing the action and its current stage of development (e.g., conceptual to construction). While some efforts are relatively certain as they are near or in construction, others are largely conceptual with uncertainty in scope or funding. Also, some efforts will have very localized and site specific effects, and may not substantially change the broader CSRM planning for the study area. Of the projects that are included in the with project assumptions, some will affect economic justification of alternatives and need to be included in the modeling of potential benefits. Below are the Fact Sheets for the 47 of these projects meeting this criterion.

The time period over which these various studies and projects may be performed or implemented is varied and oftentimes uncertain. Given this, for purposes of evaluating these projects for the FWOPC for the study, the date of the USACE Agency Decision Milestone for the study (i.e., July 2020) has been used as a cut-off date to screen which efforts are anticipated to be fully permitted, funded and into construction by that date. Of the over 160 projects that are in the works, approximately 47 could affect economic justification of alternatives and will need to be factored into economics modeling of benefits.

## Appendix Content List

### Fact Sheets

MTA NYCT Flood Mitigation in Rail Yards – Coney Island Rail Yard

MTA LIRR West Side Yard and East River Tunnel Portal Flood Mitigation

MTA NYCT Protection of Transit Street Level Openings  
NYC Comprehensive Ferry Transit Resilience Project  
NYS Staten Island Residential Buyout Program  
NYC Rockaway Line Resiliency  
NJ Transit Train Controls, Signals, Power & Communication Resiliency  
NYC Transit Flood Resiliency for Critical Bus Depots  
NYC Transit Tunnel Portals and Internal Tunnels  
Metro-North Power and Signal Resiliency  
PANYNJ Exchange Place, Newport Station & Grove Street Station Head House Protection  
PANYNJ LaGuardia Airport Mitigation  
NYC Transit Internal Station Hardening  
PANYNJ Extension of PATH Rail Yards  
LIRR Long Island City Yard Resiliency  
NYC Transit Right-of-Way Equipment Hardening  
NYC Raised Shorelines  
PVSC Passaic Valley Sewerage Commission Repairs and Mitigation  
New York NYU Langone Medical Center  
New York Flood Mitigation in Rail Yards – 207<sup>th</sup> Street  
New York New York Harbor Healthcare System  
New Jersey Hoboken Long Slip Flood Protection  
New York Amtrak Hudson Yards Concrete Casing  
New York Flood Mitigation in Rail Yards – 148<sup>th</sup> Street  
LEONJ Leonardo Costal Storm Risk Reduction Project, NJ  
JGMNJ Joseph G. Minish Park Coastal Erosion Project, NJ  
PRTPA Passaic River Tidal Protection Area, Newark, NJ  
PMNJ Port Monmouth Coastal Strom Risk Management Project, NJ  
SSSI South Shore of Staten Island Coastal Strom Risk Management Project, NY  
UBNJ Union Beach Storm Risk Management Project, NJ

NJ State Edison Pump Station Mitigation

NJ Hoboken Wet Weather Pump Station H5

NYC Lower Manhattan Coastal Resiliency Project

NJ North Hudson Sewerage Authority Mitigation

NJDEP Old Bridge MUA Laurence Harbor Floodwall

PANYNJ Concrete Sea Wall and Flood Barrier at PATH Harrison Car Maintenance Facility

FRA Penn-Moynihan Station Complex-Train-Shed Hardening Project

USACE Coney Island Coastal Storm Risk Reduction Project

NYC East Side Coastal Resiliency

NJDEP Middletown Township Sewer Authority TOMSA Mitigation

NJDEP Rebuild by Design – Hudson River

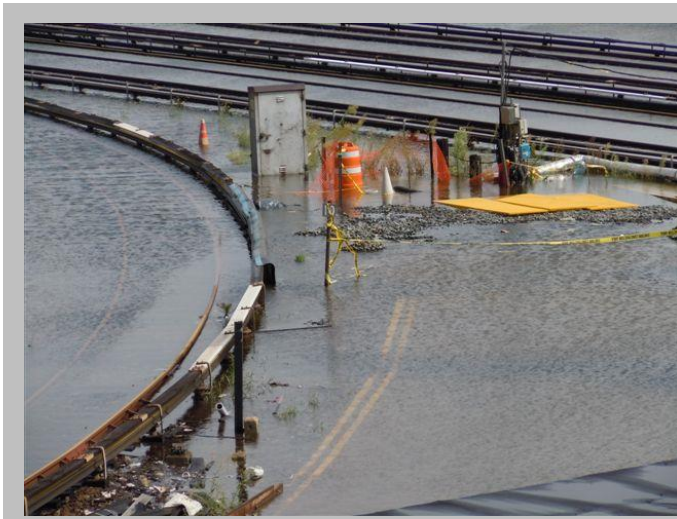
USACE Oakwood Beach Wastewater Plant Mitigation

SJ State Sayerville Pump Station Mitigation

NJDEC RBD Meadowlands Flood Protection Project

Existing Water Project Table





Source: MTA / David Knights



Source: MTA / David Knights

## Project Description

Encompassing 110 acres, three rail yards and multiple overhaul/repair shops, the Coney Island Yard Complex is the largest train storage and maintenance facility in the Metropolitan Transportation Authority (MTA) New York City Transit (NYCT) system (as shown in the project area map). Loss of the complex would shut down subway service for large portions of the NYCT system. After flooding in 2011 and 2012 severely damaged tracks and equipment and caused major subway service disruptions, the need for extensive flood mitigation at this low-lying facility were apparent. Portions of the complex are located in the preliminary 1% and 0.2% FEMA flood zones.

## Solution

Near-term projects (approximately \$13 million) completed in 2014 included a 3-mile temporary perimeter barrier and improved drainage to prevent pooling. The temporary measures employed were TrapBag and HESCO barriers, as well as barriers affixed to existing fencing. In addition, a contractor was retained to deploy sandbags along openings at the security gates and a bridge across Coney Island Creek when needed. This system provides temporary protection commensurate with the flood levels experienced during Hurricane Sandy.

The second, long-term mitigation project (anticipated \$500+ million) includes a permanent perimeter wall, about 3 miles long, surrounding the entire facility. This barrier is designed to protect the complex against the flood equivalent of the NOAA SLOSH Category 2 Hurricane plus a 3-foot safety factor, which is based on the MTA NYCT design flood elevation guidelines. The proposed design features sheet-pile wall construction.

The adaptation project also includes drainage improvements and added water retention capabilities. The design criteria for the drainage system is a 1% flood, 24-hour rainfall event. There are two proposed pump stations conveying a design capacity of 1 million gallons of stormwater. The work will include associated dry discharge lines with manifolds and engine driven deployable pumps.



The work also includes nine watertight vehicular gates, structural reinforcement of exterior building walls of traction motor shop, new track under-drainage system, track replacement in affected areas, new signal work, two new drainage outfalls to Coney Island Creek, backflow valves and tide gates, and upgrading pump capacity of existing tower A, B, and C pump rooms. Based on the preliminary design, one of the proposed flood gates is 70 feet wide and 12 feet high.

A cable bridge is being constructed to relocate traction power to an elevated and more protected position above the tracks. Bridge work will include passive tie downs of the Sea Beach Line Bridge and West End Line Bridge along Coney Island Creek and installation of debris shields from the creek's north end bridges up to the Neptune extension, hardening of bridge abutments for both creeks, and installation of a flood gate at the north end bridge. The new power and communication work includes new duct bank and manholes, installation of new traction power, control, battery cables, poles, messenger cables, communication cables, emergency alarm/emergency telephone, and other related infrastructure.

## Project Facts

*Managing Agency:* Metropolitan Transit Authority

*Primary Federal Funder:* U.S. Department of Transportation, Federal Transit Administration

*Project Status:* Planning and Design Phase. Construction of the near-term perimeter protection at Coney Island Yard is projected to end August 2019. The long-term perimeter protection is projected to begin March 2018 and end in October 2022.

*Project Elevation (ft NAVD88):* SLOSH Category 2 Hurricane + 3-foot safety factor based on MTA NYCT guidance. Site-specific project crest elevations could not be determined. The FEMA base flood elevation for the complex is AE10-11.

### Areas of Reduced Risk

- **Coney Island Rail Yard Complex**
- **Sea Beach Line Bridge**
- **West End Line Bridge**

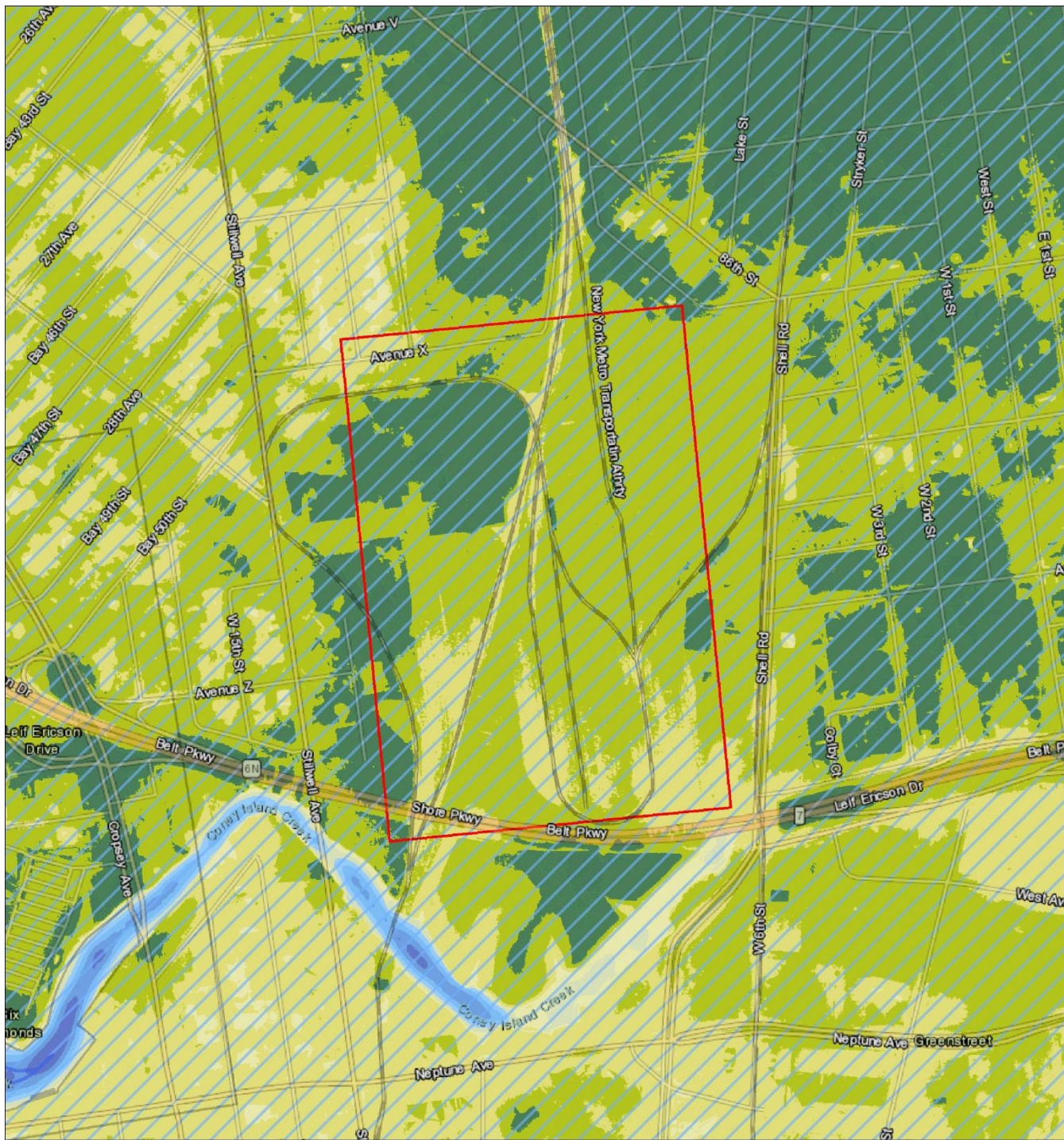


## References

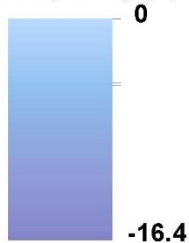
1. Cabrera, A; K. Mooney, M. Naik. (n.d). *Design Guidelines Regarding Resiliency and Protection Against Potential NYCTS Flooding due to Hurricane Storm Surges*. Received via personal communication with MTA representatives.
2. Metropolitan Transportation Authority (MTA). (n.d.) *MTA Climate Adaptation Task Force Resiliency Project*. Accessed January 2018. Available at <http://web.mta.info/sustainability/pdf/ResiliencyReport.pdf>.
3. MTA. Capital Program Dashboard. Accessed June 1, 2018. Available at: <http://web.mta.info/capitaldashboard/CPDHome.html?AGENCY=a&PLN=Z>
4. MTA / David Knights. (2011). *Coney Island yard flood levels 004*. Accessed March 13, 2018. Available at <https://www.flickr.com/photos/mtaphotos/6089071899/>.
5. MTA / David Knights. (2011). *Coney Island yard flood levels 003*. Accessed March 13, 2018. Available at <https://www.flickr.com/photos/mtaphotos/6089071863/>.
6. STV, Inc. (2016). *Project Example Coney Island Yard Flood Wall, Brooklyn, NY*. Accessed June 1, 2018. Available at [http://nj.gov/comptroller/sandytransparency/contracts/pdf/stv2\\_proposal.pdf](http://nj.gov/comptroller/sandytransparency/contracts/pdf/stv2_proposal.pdf).



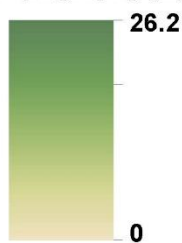




Bathymetry (ft)



Topography (ft)

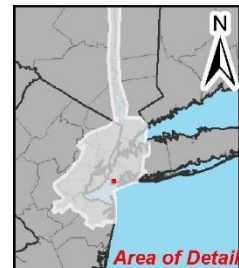


Flood Mitigation in Rail Yards: Coney Island Rail Yard, Brooklyn



1,000 Year Flood Extent (0.1% annual chance)

0 0.1 0.2 Miles







Source: Metropolitan Transportation Authority / Patrick Cashin



Source: Metropolitan Transportation Authority / Patrick Cashin

## Project Description

The West Side Yard and East River Tunnel Portal Flood Mitigation Project is a joint effort led by the Long Island Rail Road (LIRR) and Amtrak (as shown in the project area map). The project aims to ensure connectivity of service on the LIRR and Amtrak commuter rail systems over the Hudson and East Rivers, which transport approximately 560,000 commuters every weekday. Portions of the complex are located in the preliminary 1% (AE11-12) and 0.2% FEMA flood zones.

During Hurricane Sandy, floodwaters entered the West Side Yard from the Hudson River, damaging critical infrastructure including track beds, switches, and signals, and entering the North River Tunnel's two tubes from the Manhattan portal at 10<sup>th</sup> Avenue and the ventilation shaft at 11<sup>th</sup> Avenue.

While significant efforts made prior to landfall of Hurricane Sandy led to reduced equipment damage and prompt resumption of service, additional preparations can decrease the potential for damage and lead to shorter recovery time. Once completed, the LIRR will be responsible for the operations and maintenance of West Side Yard, and the LIRR and Amtrak will be jointly responsible for the operations and maintenance of the East River portals. Required permits for this project will be obtained by the design-build contractor and issued to New York City Department of Transportation (NYCDOT), Amtrak, and New York City Department of Environmental Protection (NYCDEP). Both the Metropolitan Transportation Authority (MTA) and the LIRR have authority to make modifications to the project if needed.

## Solution

LIRR is planning perimeter and drainage improvements around the West Side Yard, which also encompasses the North River Tunnel's vent shaft and portal. The new, permanent perimeter wall will include additional deployable barriers across driveways and access points in advance of storm events, aimed at reducing flood risk for all rail elements within the yard complex, including the North River Tunnel portal, vent shaft, and other openings.



Proposed improvements also include hardening of western portals, North River Tunnels, hardening of eastern portals, East River Tunnels, and floodproofing Penn Station and West Side Yard. The new perimeter wall will also encompass the new portal for the Hudson River Tunnel and the 10<sup>th</sup> Avenue fan plant, which will be located above the A Yard tracks. The project will be built to withstand a flood elevation corresponding to the FEMA base flood elevation (BFE) + 4 feet, which aligns with Federal Transit Administration (FTA) and LIRR standards. This project aims to mitigate vulnerabilities within the commuter rail system by improving the sections that span the Hudson and East Rivers.

## Project Facts

*Managing Agency:* Metropolitan Transit Authority

*Primary Federal Funder:* U.S. Department of Transportation, Federal Transit Administration

*Project Status:* Planning and Design Phase (30% Design). Once completed, a Request for Proposal for a Design-Build contractor will be advertised using a competitive bid process. Construction of the project is anticipated to begin in June 2018 and end in February 2022.

*Project Elevation (ft NAVD88):* FEMA base flood elevation (BFE) + 4 feet (based on the FEMA BFE, the estimated project elevation is +15-16 ft NAVD88).

## Areas of Reduced Risk

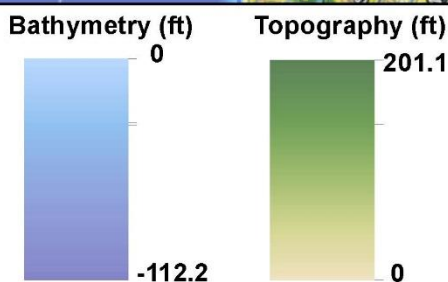
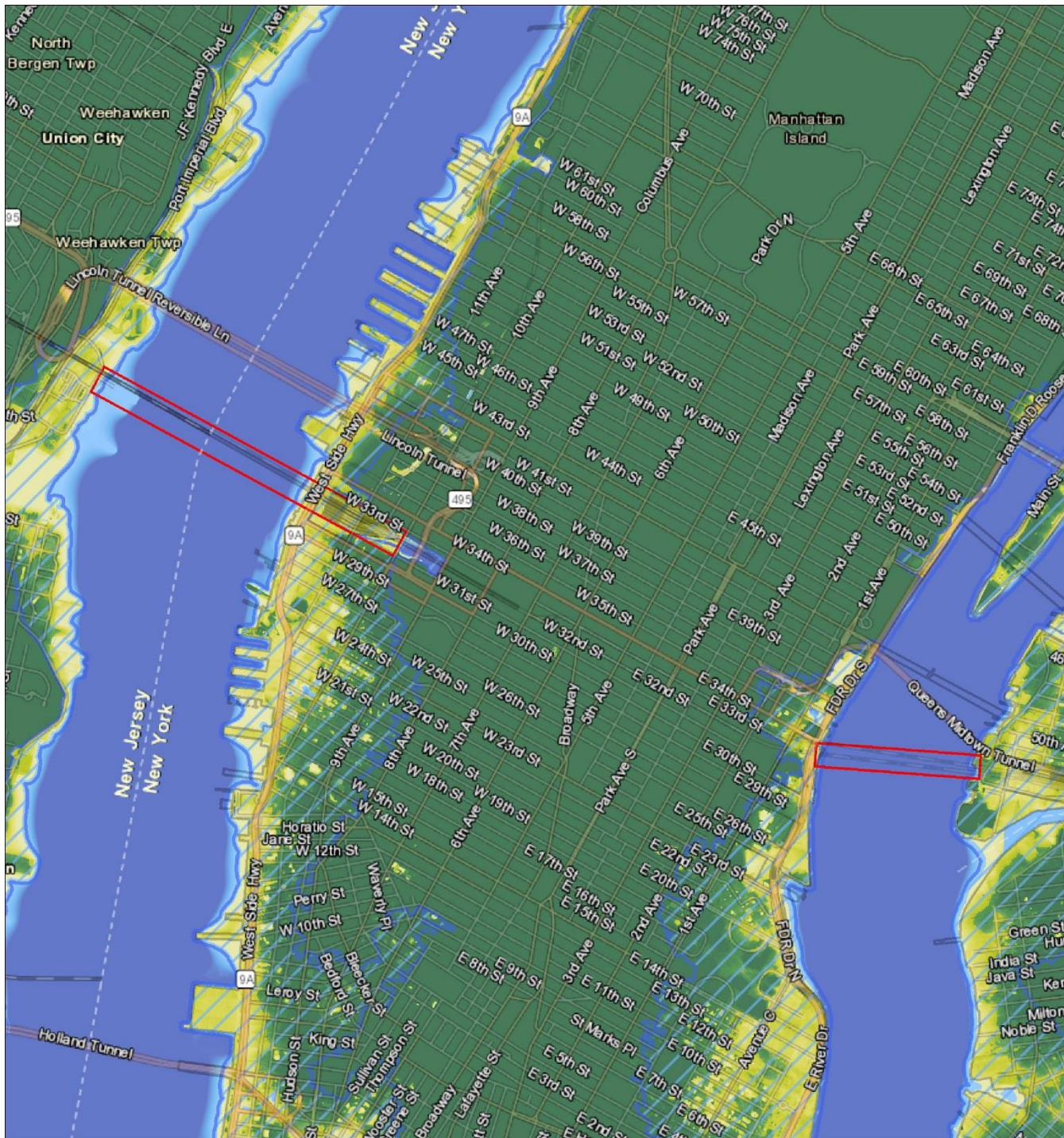
- **Western portals of the North River Tunnels in Weehawken, NJ**
- **Eastern portals of the East River Tunnels in Queens, NY (Lines 1–4)**
- **Penn Station**
- **West Side Yard**

## References

1. Dutta, P. (February 27, 2018). Personal communication.
2. Metropolitan Transit Authority (MTA). Capital Program Dashboard. Accessed June 1, 2018. Available at: <http://web.mta.info/capitaldashboard/CPDHome.html?AGENCY=a&PLN=Z>
3. MTA / Patrick Cashin. (2012). *NYCT\_5917*. Accessed March 13, 2018. Available at <https://www.flickr.com/photos/mtaphotos/8159587739/>.
4. MTA / Patrick Cashin. (2012). *NYCT\_5975*. Accessed March 13, 2018. Available at <https://www.flickr.com/photos/mtaphotos/8159621140/>.
5. New Jersey Transit. (2017). *The Hudson Tunnel Project Draft EIS and Draft Section 4(f) Evaluation, Chapter 20 Indirect and Cumulative Effects*. Accessed June 1, 2018. Available at <http://www.hudsonstunnelproject.com/documents/deis/20%20Indirect%20and%20Cumulative%20Effects.pdf>
6. New York State. (2014). Governor Cuomo Announces More than \$1.9 Billion in Federal Storm Resiliency Funding. Accessed November 2017. Available at <https://www.governor.ny.gov/news/governor-cuomo-announces-more-19-billion-federal-storm-resiliency-funding>







- West Side Yard and East River Tunnel Portal Flood Mitigation
- 1,000 Year Flood Extent (0.1% annual chance)

0 0.5 1 Miles







Source: Metropolitan Transportation Authority / Patrick Cashin



Source: MTA New York City Transit / Marc Hermann

## Project Description

During extreme weather events, street level openings for Metropolitan Transportation Authority (MTA) New York City Transit (NYCT) are vulnerable to floodwaters, which cause damage to electrical and structural equipment, disrupting transit service. Flood proofing and hardening of key street level openings will minimize damage from future extreme weather events by preventing flooding within the subway system.

## Solution

This project addresses flood risk for street level openings throughout the five boroughs from the flood equivalent of the NOAA SLOSH Category 2 Hurricane plus a 3-foot safety factor, which is based on the MTA NYCT design flood elevation guidelines. Within the FEMA 1% and 0.2% flood zones, 5,600 vulnerable street openings were identified, including 109 street stairs; 3,087 vent bays; 104 hatches; 461 manholes; 1,285+ duct entries; 7 elevators; and 7 escalators. Exact locations of these street openings were not available, thus the project area map shows the NYC boroughs with the floodplain. These locations will be targeted for additional floodproofing and hardening measures. Specific improvements include the installation of temporary flood barriers with a focus on improvements that will be easy to deploy prior to extreme weather events. Additional measures may include watertight doors and hatches, flexible flood gates, and mechanical vent closure devices. Permits for this project vary by contract and location. MTA and NYCT will have future project modification authority and operations and maintenance responsibility.





## Project Facts

*Managing Agency:* Metropolitan Transit Authority (MTA)

*Primary Federal Funder:* U.S. Department of Transportation, Federal Transit Administration (FTA). grant funding was awarded in 2015.

*Project Status:* Construction started July 2016 and is anticipated to end January 2020.

*Project Elevation (ft NAVD88):* SLOSH Category 2 + 3 feet (varies by location). Many solutions involve sealing or floodproofing openings at entrances at grade, thus specific project elevations are not defined.

## Areas of Reduced Risk

- **NYCT street-level openings within 1% and 0.1% floodplains throughout Manhattan, Brooklyn, Queens, The Bronx, and Staten Island**

## References

1. Cabrera, A; K. Mooney, M. Naik. (n.d). *Design Guidelines Regarding Resiliency and Protection Against Potential NYCTS Flooding due to Hurricane Storm Surges*. Received via personal communication with MTA representatives.
2. Dutta, P. (February 27, 2018). Personal communication.
3. Metropolitan Transit Authority (MTA). 2015. *Capital Program Oversight Committee Meeting, July 20, 2015*. Accessed June 1, 2018. Available at [http://web.mta.info/mta/news/books/archive/150720\\_1345\\_CPOC.pdf](http://web.mta.info/mta/news/books/archive/150720_1345_CPOC.pdf)
4. MTA. Capital Program Dashboard. Accessed June 1, 2018. Available at: <http://web.mta.info/capitaldashboard/CPDHome.html?AGENCY=a&PLN=Z>
5. MTA / Patrick Cashin. 2017. *Superstorm Sandy: Damage and Resiliency Work*. Accessed March 13, 2018. Available at <https://www.flickr.com/photos/mtaphotos/24120475918/>.
6. MTA New York City Transit / Marc Hermann. 2013. *Sandy Resiliency Tour at Whitehall St. Station*. Accessed March 13, 2018. Available at <https://www.flickr.com/photos/mtaphotos/10558261955/>.









Source: NOAA



Source: The National Guard, 3-126th Aviation

## Project Description

The Staten Island Ferry transports passengers between the Whitehall Ferry Terminal in Manhattan and the St. George Ferry Terminal on Staten Island, NY (as shown in the project area map). The ferry currently provides service free-of-charge to approximately 22 million people a year, including daily commuters and weekend travelers. The ferry is operated and maintained by New York City Department of Transportation (DOT). There are currently nine vessels in the fleet. This project aims to increase resiliency of the ferry service by acquiring two new vessels with capability to operate in a range of weather conditions. St. George and Whitehall terminals and the Staten Island Ferry Maintenance Facility were considerably damaged during Hurricane Sandy. Updates to both terminals in Manhattan and Staten Island will be made to accommodate the new side-boarding vessels and improve flood resilience. Both terminals are located in the preliminary 1% (AE12-VE17) and 0.2% FEMA flood zones.

## Solution

Two modern vessels with 4,500-passenger capacity will be added to the Staten Island Ferry fleet. The vessels will be able to operate in a range of weather conditions and dock at a greater number of landings than the current ferries. Vital landings not equipped to support the new ferries will be updated to accommodate them. The ferries will allow for side boarding of the vessels to be used in evacuations, if needed. The St. George and Whitehall terminals and the Staten Island Ferry Maintenance Facility will be dry and wet flood proofed. Funding will also be used to modify facilities at critical locations to accommodate new vessels, while hardening the landings against damage from future storms and the effects of sea level rise. The landing enhancement will occur at four locations - Hunters Point and East 34<sup>th</sup> Street are the priority and two others, at least one of which that will likely be in Brooklyn. There will be two "flex barges," capable of being deployed to multiple locations, in addition to the four modified landings.



## Project Facts

*Managing Agency:* New York City DOT

*Primary Federal Funder:* U.S. DOT, Federal Transit Administration

*Project Status:* Planning and Design Phase

*Project Elevation (ft NAVD88):* No data available.

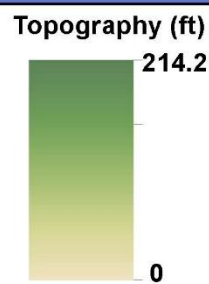
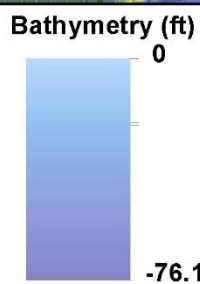
## Areas of Reduced Risk

- Areas of Staten Island
- St. George Ferry Terminal
- Whitehall Ferry Terminal

## References

1. SIFerry.com. (n.d.). *The Staten Island Ferry*. Accessed November 2017. Available at <http://www.siferry.com/>.
2. Office of Senator Charles E. Schumer. (2014). *Press Release: Schumer, Gillibrand, De Blasio Announce \$190m in Federal Funding for Two New Ferry Boats for Staten Island; Updated Boats Will Offer Critical Resiliency in the Face of Future Storms Like Sandy*. Accessed June 1, 2018. Available at <https://www.schumer.senate.gov/newsroom/press-releases/schumer-gillibrand-de-blasio-announce-190m-in-federal-funding-for-two-new-ferry-boats-for-staten-island-updated-boats-will-offer-critical-resiliency-in-the-face-of-future-storms-like-sandy>.
3. WNYC. (September 17, 2014). *Staten Island Ferry Gets Major Storm Safety Upgrade*. Accessed November 2017. Available at <http://www.wnyc.org/story/staten-island-ferry-gets-major-storm-safety-upgrade/>.
4. NYCDOT. (September 22, 2014). *United States Department of Transportation, Counselor to the President John Podesta, NYC Department of Transportation Commissioner, Congress Member Nadler, Meeks, Crowley and Meng Announce Funding for Sandy Resilience*. Accessed January 2018. Available at <http://www.nyc.gov/html/dot/html/pr2014/pr14-usdot.shtml>.
5. National Oceanic and Atmospheric Administration (NOAA). (2004). *Staten Island Ferry. New York Harbor. Fall 2003*. Accessed February 4, 2018. Available from Flickr <https://www.flickr.com/photos/51647007@N08/5434649376/>.
6. The National Guard. (2014). *New York National Guard*. Accessed February 4, 2018. Available from Flickr <https://www.flickr.com/photos/thenationalguard/13717233245/in/photostream/>.

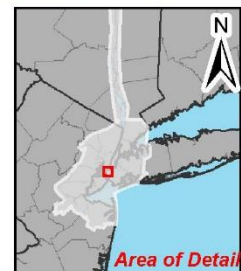




NYC Comprehensive Ferry Transit Resilience Project

1,000 Year Flood Extent (0.1% annual chance)

0 0.5 1 Miles







Source: Andrea Booher/FEMA



Source: Tim Burkitt/FEMA

## Project Description

Staten Island is the southernmost borough of New York City and is home to approximately 475,000 residents. During Hurricane Sandy, the island experienced widespread flooding that damaged many residential properties and led to power outages for 120,000 customers.

The Staten Island Residential Buyout program, led by New York State, is one of several initiatives aimed at relocating residents from areas with high vulnerability to flooding. The buyout program offers property owners within the 1% floodplain fair market value (based on valuation data prior to Hurricane Sandy). The program encourages residents to resettle in locations less vulnerable to flooding so they are removed from immediate danger of flooding emergencies. The properties purchased through the buyout program are converted to permanent public open spaces such as parks and wetlands (as shown in the project map). Based on the May 2017 NYC presentation, areas are targeted but specific locations were not identified. Thus, a broad map of Staten Island is presented. The public land will be restored with capability of storing and abating floodwaters, which will protect inland communities by reducing flooding extents.

## Solution

Under the scope of the Staten Island initiative, 520 residential properties will be purchased in flood-prone areas and converted to permanent public open space. The buyouts are funded by a U.S. Department of Housing and Urban Development (HUD) Community Development Block Grant Disaster Recovery (CDBG-DR)

grant; eligible costs include demolition, basement filling, and site restoration. Two programs at the City and the State level have identified this incongruity of coastal risk and residential land use: the State of New York's NY Rising Buyout Program has established two different buyout zones with the objective of returning extreme risk areas back to a natural wetland state. In the months following Hurricane Sandy, the New York State Office of Storm Recovery (GOSR) designated the Oakwood Beach, Ocean Breeze,

### Areas of Reduced Risk

- **Staten Island**



and Graham Beach neighborhoods as Enhanced Buyout Areas due to high flood risk and the overall communities' support to participate in the program. Within these defined boundaries the State offered to buy homes at pre-storm value that sustained substantial damage as a result of Hurricane Sandy, Tropical Storm Lee, or Hurricane Irene. These areas were determined to be most at risk in future disasters due to their low lying elevations and proximity to the coast.

## Project Facts

*Managing Agency:* New York State Housing Trust Fund Corporation (NYS HTFC)

*Primary Federal Funder:* U.S. Department of Housing and Urban Development

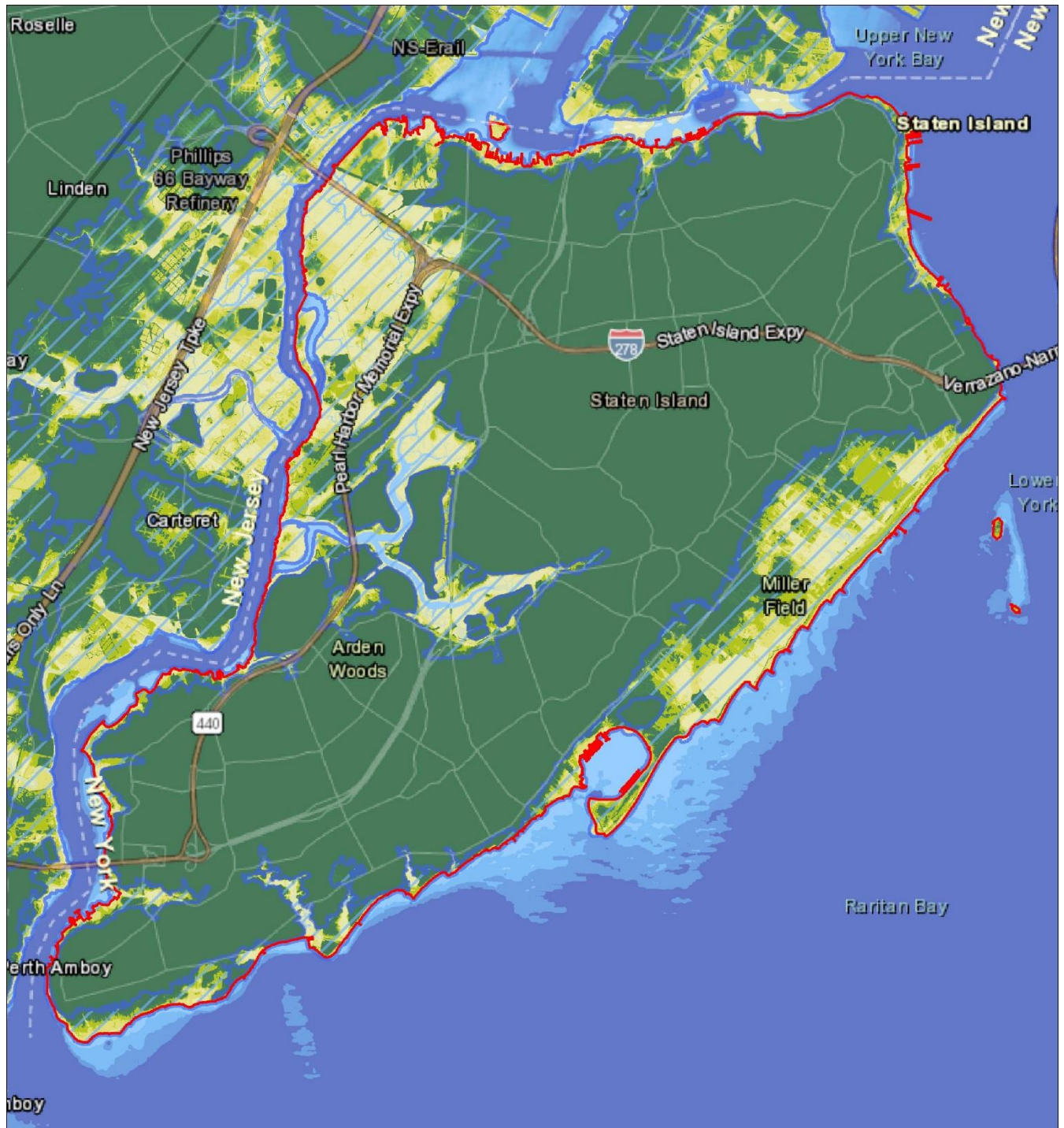
*Project Status:* Pre-Construction Phase

*Project Elevation (ft NAVD88):* Not applicable. These 520 structures will be removed from calculations of potential benefits of proposed storm risk management features.

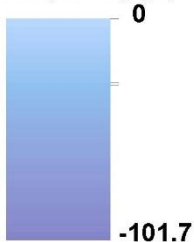
## References

1. The City of New York. (2017). *Resilient Neighborhoods: East Shore, Staten Island*. Accessed June 1, 2018. Available at <https://www1.nyc.gov/assets/planning/download/pdf/plans-studies/resilient-neighborhoods/east-shore/summary-report-east-shore.pdf>
2. The City of New York. (May 10, 2017). *East Shore Buyout Areas Special Coastal Risk District and Rezoning*. Accessed June 1, 2018. Available at <https://www1.nyc.gov/assets/planning/download/pdf/plans-studies/resilient-neighborhoods/east-shore/east-shore-presentation-cb3.pdf>
3. The City of New York. (June 11, 2013). *A Stronger, More Resilient New York, Chapter 1*. Available at [http://www.nyc.gov/html/sirr/downloads/pdf/final\\_report/Ch\\_1\\_SandyImpacts\\_FINAL\\_singles.pdf](http://www.nyc.gov/html/sirr/downloads/pdf/final_report/Ch_1_SandyImpacts_FINAL_singles.pdf). Accessed November 2017.
4. The City of New York. (September 7, 2017). *East Shore Neighborhoods Resilient Neighborhoods Study*. Available at <http://www1.nyc.gov/site/planning/plans/resilient-neighborhoods/east-shore-rezoning.page>
5. Federal Emergency Management Agency (FEMA). (2012). *Staten Island, N.Y., Nov. 10, 2012*. Accessed February 8, 2018. Available from <https://www.fema.gov/media-library/assets/images/68514>.
6. FEMA. (2012). *Debris removal starting on Staten Island*. Accessed February 13, 2018. Available from <https://www.fema.gov/media-library/assets/images/66715>.
7. U.S. Census Bureau. (n.d.). *Quick Facts: Richmond County (Staten Island Borough), New York*. Available at <https://www.census.gov/quickfacts/fact/table/richmondcountystatenislandboroughnewyork/PST045216>. Accessed November 2017

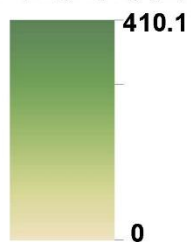




Bathymetry (ft)



Topography (ft)



Staten Island Residential Buyout Program

1,000 Year Flood Extent (0.1% annual chance)

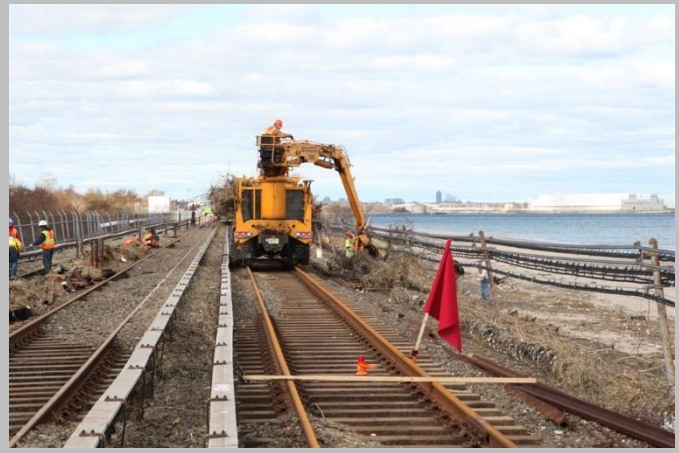
0 1.5 3 Miles







Source: MTA / Leonard Wiggins



Source: MTA / Leonard Wiggins

## Project Description

This project focuses on Rockaway Line stations, track, and facilities on Rockaway Flats and Rockaway Peninsula in Queens, NY, and other areas adjacent to Jamaica Bay (as shown in the project area map). The severe storm surge during Hurricane Sandy caused extensive damage, including flooding of more than 3 miles of rail line across Jamaica Bay and 0.25-mile breach that disrupted service and necessitated a 7 month shutdown of the subway link to the Rockaways. Two flood prone stations and other assets critical to the Rockaway Line require flood mitigation.

## Solution

Preliminary scope components under study include washout and debris protection along Rockaway Flats and Subway Island. A crossover to provide operational resiliency at Rockaway Park and provide service flexibility after storms is being designed for Beach 105th Street Station. Long-term flood protection of the Hammels Wye Campus, including a substation and other critical assets, is proceeding into construction.

During the project, crews will construct a perimeter flood wall and flood gates, as well as construct a new compressor building within the flood wall. Sheet pile construction of the wall will have foundations set 30-feet below ground and be approximately 10-feet above grade. In order to minimize the impact on customers and the local community, and complete this necessary work in a timely fashion, the work will be conducted in two separate phases, impacting only one side of the Rockaways at a time.

A U.S. Army Corps of Engineers (USACE) and New York State Department of Environmental Conservation (NYSDEC) joint permit is anticipated for Rockaway Line Protection. A New York City Department of Parks & Recreation (NYC Parks) permit is being acquired for Hammels Wye Campus Long-Term Flood Mitigation. Metropolitan Transit Authority (MTA) and New York City Transit (NYCT) will have future project modification authority and operations and maintenance responsibility.



## Project Facts

*Managing Agency:* Metropolitan Transit Authority (MTA)

*Primary Federal Funder:* U.S. Department of Transportation, Federal Transit Administration (FTA); grant funding was awarded in 2015

*Project Status:* Phase I construction in April 2018 along Rockaway Park Branch, Phase 2 construction along the Far Rockaway Branch. For Hammels Wye, construction is anticipated to end in May 2019. For the crossovers at Beach 105th Street, design is anticipated to end in August 2019.

*Project Elevation (ft NAVD88):* Based on an estimated ground surface elevation and project description, the minimum estimated project elevation is 14 feet NAVD88.

## Areas of Reduced Risk

- **Howard Beach Station**
- **Broad Channel Station**
- **Hammels Wye facilities**
- **Right-of-way between stations, related substations and a relay room**
- **Beach 105<sup>th</sup> Street Station**

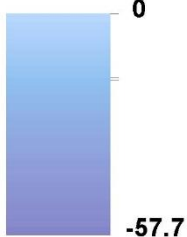
## References

1. Dutta, P. (February 27, 2018). Personal communication.
2. New York State. (September 17, 2014). *Governor Cuomo Announces More than \$1.9 Billion in Federal Storm Resiliency Funding*. Accessed November 2017. Available at <https://www.governor.ny.gov/news/governor-cuomo-announces-more-19-billion-federal-storm-resiliency-funding>.
3. Metropolitan Transit Authority (MTA). 2015. Capital Program Oversight Committee Meeting. Accessed June 1, 2018. Available at [http://web.mta.info/mta/news/books/archive/150720\\_1345\\_CPOC.pdf](http://web.mta.info/mta/news/books/archive/150720_1345_CPOC.pdf)
4. Metropolitan Transit Authority (MTA). n.d. Accessed June 1, 2018. Available at [http://web.mta.info/capitaldashboard/10\\_14/agencies/e/dashboarda.htm](http://web.mta.info/capitaldashboard/10_14/agencies/e/dashboarda.htm)
5. MTA. 2018. *Press Release: NYC Transit Starting Subway Flood Protection Project in Rockaways Next Month*. Accessed June 1, 2018. Available at <http://www.mta.info/press-release/nyc-transit/nyc-transit-starting-subway-flood-protection-project-rockaways-next-month>
6. New York State. 2017. *News: MTA Calls Climate Change 'Urgent Reality' as It Launches New Report on Preparation for Sea Level Rise and Other Coastal Dangers*. Accessed June 1, 2018. Available at [https://apps.cio.ny.gov/apps/mediaContact/public/view.cfm?parm=AB8FB0BC-5056-907F-6F3587B1A32274EE\\_DC27CC19-5056-9076-640FF9D9E9BA4CF6](https://apps.cio.ny.gov/apps/mediaContact/public/view.cfm?parm=AB8FB0BC-5056-907F-6F3587B1A32274EE_DC27CC19-5056-9076-640FF9D9E9BA4CF6)
7. MTA / Leonard Wiggins. 2012. *16. Boat washed across Tracks*. Accessed March 13, 2018. Available at <https://www.flickr.com/photos/mtaphotos/8142738428/>.
8. MTA / Leonard Wiggins. 2012. *19. Contractors Removing Damaged Fencing in the Rockaway's*. Accessed March 13, 2018. Available at <https://www.flickr.com/photos/mtaphotos/8152150679/>.

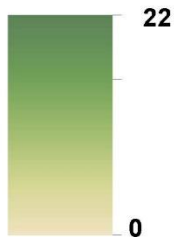




Bathymetry (ft)



Topography (ft)



- NYC Transit Rockaway Line Protection
- 1,000 Year Flood Extent (0.1% annual chance)

0 0.25 0.5 Miles







Source: George Armstrong/FEMA



Source: Chris Gardner/U.S. Army Corps of Engineers

## Project Description

The Wayside Signals, Power, and Communication Resiliency project for NJ TRANSIT commuter and light rail lines will improve critical signals, track switches, speed controls, and safety controls that are vulnerable to storm surge and inland flooding. These systems are used for control of train speed, following distances, and switch and track selection. In addition to the Wayside project, NJ TRANSIT is also advancing other projects to repair portions of the signal and controls systems damaged by Hurricane Sandy and is elevating assets that are vulnerable to flooding. The NJ Transit Complementary Signal Resiliency projects provide repair and flood preparations for facilities in Hoboken Terminal, and along sections of the North Jersey Coast Line, Hudson-Bergen Light Rail, and Newark Light Rail.

These assets are located within the 1% annual chance coastal and inland floodplain (as shown in the project area map), where a coastal or riverine event could overtop the trackbed and potentially damage signal, power, and communications systems critical to safe operations.

## Solution

Within inland floodplains, assets will be raised to at least 1.5 feet above FEMA Base Flood Elevation (BFE). Within coastal floodplains, assets will be raised to at least 2.5 feet above the BFE to account for the potential of an additional 1-foot sea level rise over the asset's 50-year lifecycle. Repairs related to Wayside Power Systems in Yard B and Days Yard are near completion, which will raise equipment above flood elevation and add power outlets and control stations for up to 20 tracks. In addition to their resiliency benefits, these systems will provide stand-by power for stored trains, reducing emissions and noise.



## Project Facts

*Managing Agency:* New Jersey Transit

*Primary Federal Funder:* U.S. Department of Transportation, Federal Transit Administration

*Project Status:* Currently in planning and design, estimated completion date 2021. Advertisement of these contracts is planned for 2018, with actual field work to start the following year.

*Project Elevation (ft NAVD88):* Varies, 1.5 feet to 2.5 feet above BFE depending on flooding source. Based on intersection of transit line and FEMA flood zones, the following BFEs were estimated along each transit line:

- Bergen County Line: AE8-9
- Main Line: AE6-9
- Meadowlands Rail Line: AE8
- North Jersey Coast Line: AE9 to VE16 (crosses many waterbodies)
- Northeast Corridor: AE10 to VE16 (crosses many waterbodies)
- Pasack Valley Line: AE5-8
- Waterfront Connection: AE9
- Hoboken Terminal: AE9

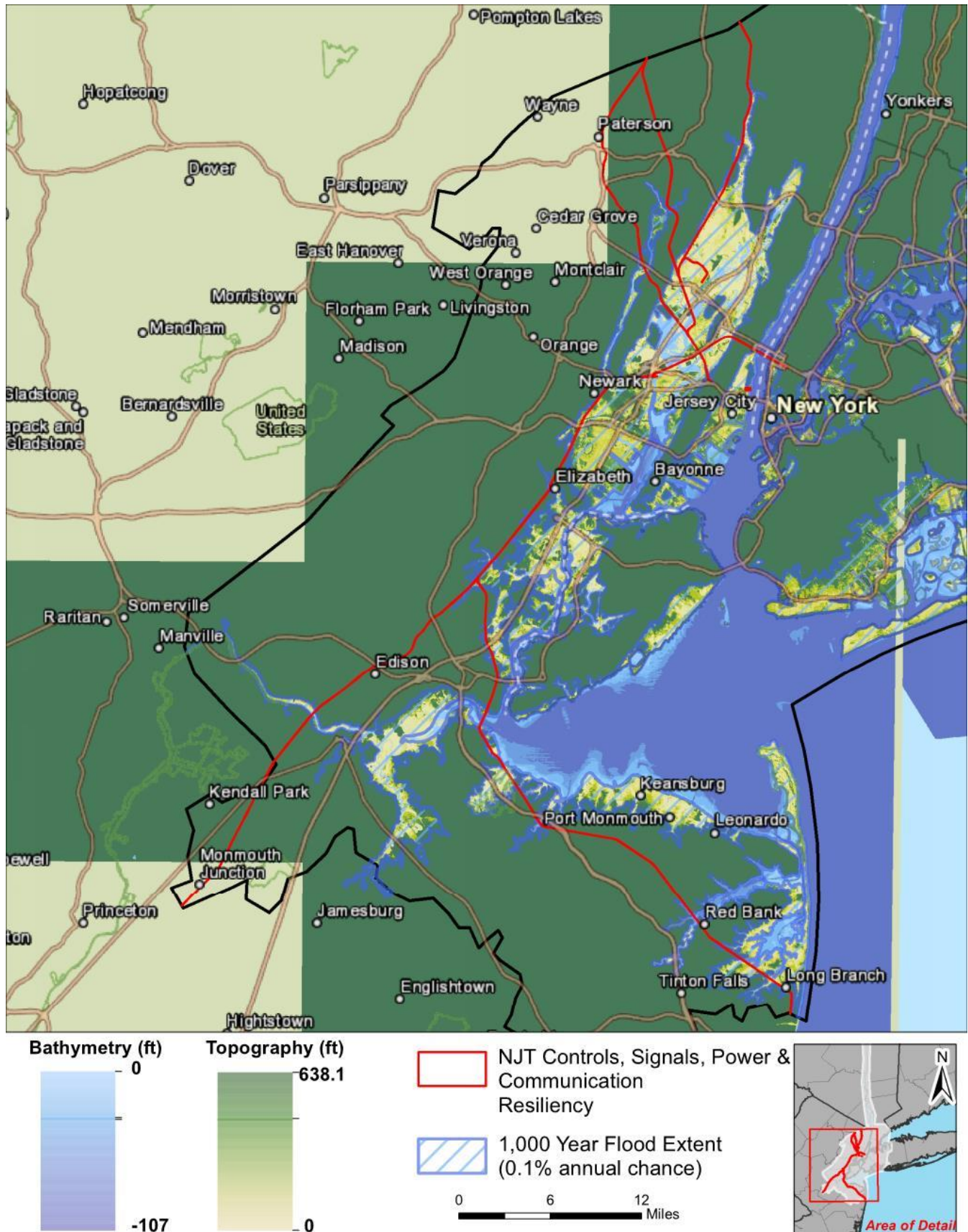
## Areas of Reduced Risk

- **Hudson-Bergen Light Rail Line**
- **Four NJ TRANSIT commuter rail lines are targeted for hardening — Main, Bergen, Pascack Valley Lines, and Morris & Essex (M&E) Lines—and the Meadows Maintenance Complex Maintenance Facility**
- **Some segments may coincide with regional community-scale resilience projects such as Region by Design Hudson River and Meadowlands projects**

## References

1. NJ Transit. (n.d.). *Signals & Communications Resilience*. Available at <http://njtransitresilienceprogram.com/signals-communications-overview/>. Accessed October 2017.
2. NJ Transit. (2017). *NJ Transit Major Project Status*. Accessed June 1, 2018. Available at: <http://www.state.nj.us/transportation/capital/stip1827/sec11/pdf/transit.pdf>
3. NJ Transit (2017). *NJ Transit 2017 Annual Report*. Accessed June 1, 2018. Available at: [www.njtransit.com/pdf/NJTRANSIT\\_2017\\_Annual\\_Report.pdf](http://www.njtransit.com/pdf/NJTRANSIT_2017_Annual_Report.pdf)
3. FEMA. 2012. *Transit Employees Repair Storm Damaged Coaches*. Accessed February 13, 2018. Available at <https://www.fema.gov/media-library/assets/images/67243>.
3. USACE. 2011. *USACE Bound Brook, NJ Site Visit*. Accessed February 11, 2018. Available at <https://www.flickr.com/photos/usacehq/6254632118/>.









Source: MTA New York City Transit / Vito Siculo



Source: MTA New York City Transit / Marc Hermann

## Project Description

Metropolitan Transportation Authority (MTA) received funding from the Federal Transit Authority for floodproofing at four bus depots throughout New York City in the 1% annual chance floodplain. The floodproofing project involves installing drainage, flood gates, deployable barriers, and other equipment to prevent water intrusion to vulnerable bus depots. During Hurricane Sandy in 2012, bus depot personnel worked around the clock to pump water out of depot sub-basements to protect mechanical equipment. Some flooding occurred, but only sump pumps were damaged and required replacement. Following Hurricane Sandy, MTA New York City Transit ordered flood mitigation studies and began developing new emergency preparedness and recovery plans. Two bus depots are on Staten Island, one depot is in Manhattan, and one depot is in Queens. The Far Rockaway depot and the Michael J. Quill depot are located in the preliminary 1% (AE10-11) FEMA flood zone. The Castleton depot is located in the preliminary 0.2% FEMA flood zone. The fourth depot was not explicitly identified in the 2017 MTA Resiliency Report. However, the MTA Capital Plan dashboard lists the Casey Stengel and Yukon depots as other locations with possible flood mitigation projects.

## Solution

The resiliency solutions for bus depots will include drainage improvements, installation of a swing gate or side flex wall, protection of buses on the roof top of the depot, and procurement of new emergency diesel generators and mobile pumps. Measures will also include installation of protective doors and additional capacity power generators. Where applicable more robust measures will be considered, such as relocation of equipment to higher areas, replacement of below-ground storage tanks, backflow preventers, auxiliary pumping equipment, and installation of sea walls. Detailed mitigation measures were only available for the Far Rockaway and Michael J. Quill bus depots. Similar efforts are expected to take place at other critical, vulnerable bus depot locations.

At the Far Rockaway depot, specific adaptation measures include:

- Distribution to all depots of new emergency procedures model, incorporating lessons learned,
- Procurement of new emergency generators and high-capacity mobile pumping equipment,
- Relocation of the main electrical distribution room to the second floor, above 0.2% flood levels, and



- Redesign and construction of areas most effected by storm damages.

At the Michael J. Quill depot, specific adaptation measures include:

- Development and distribution of a new NYCT Bus Operations Coastal Storm Plan,
- Review and recommendation of dry floodproofing, using either a swing gate or side flex wall,
- Overhead protection of buses parked at roof parking lot, and
- Procurement of emergency generators and high-capacity mobile pump equipment

## Project Facts

*Managing Agency:* Metropolitan Transportation Authority (MTA)

*Primary Federal Funder:* U.S. Department of Transportation, Federal Transit Administration (FTA)

*Project Status:* Planning and Design Phase ended in 2017. For the Far Rockaway depot, construction is anticipated to end in 2018. Limited information was available for other depots.

*Project Elevation (ft NAVD88):* Based on the intersection of the locations and flood zones, the BFEs are between AE8-10.

## Areas of Reduced Risk

- Two bus depots on Staten Island
- One bus depot in Manhattan
- One bus depot in Queens

## References

1. Metropolitan Transportation Authority (MTA). (2017) MTA Climate Adaptation Task Force Resiliency Project. Accessed February 2018. Available at <http://web.mta.info/sustainability/pdf/ResiliencyReport.pdf>
2. MTA. Capital Program Dashboard. Accessed June 1, 2018. Available at: <http://web.mta.info/capitaldashboard/CPDHome.html?AGENCY=a&PLN=Z>
3. MTA New York City Transit / Vito Siculo. 2012. *Castleton Depot Sandbagging 1*. Accessed March 13, 2018. Available at <https://www.flickr.com/photos/mtaphotos/8136676811/>.
4. MTA New York City Transit / Marc Hermann. 2014. *Mother Clara Hale Bus Depot*. Accessed March 13, 2018. Available at <https://www.flickr.com/photos/mtaphotos/15216353134/>.







Source: MTA New York City Transit / Leonard Wiggins



Source: MTA / George Von Dolln

## Project Description

Metropolitan Transportation Authority (MTA) was awarded grant funding in 2015 to reduce the risk of floodwaters entering and traversing underground infrastructure through sealings and other vulnerable openings. MTA New York City Transit (NYCT) subways are vulnerable to climate change impacts, rising sea levels, and storm surges from coastal weather events due to the low elevation of the infrastructure. The subway network is an electric-powered system operating largely below ground, with 14 under-river tunnels and extensive assets in coastal flood zones.

## Solution

Specific locations targeted as part of this project include the 148th Street, 207th Street, and Hunters Point portals. The 148th Street portal will be protected by deployable stop logs. The 207th Street and Hunters Point portals will be protected using Flex-Gates, which are high-strength closures that can be deployed quickly before extreme weather events.

Additional project work to seal internal tunnels will include deployable track barriers and pumping improvements at various locations. This barrier is designed to protect the complex against the flood equivalent of the NOAA SLOSH Category 2 Hurricane plus a 3-foot safety factor, which is based on the MTA NYCT design flood elevation guidelines. Design is ongoing for various components and locations of this project. Other sites and facilities considered for protection include the Consolidated Revenue Facility, Zerega Depot, and the Tiffany Storeroom.

As of 2018, there are no applicable permits required for this project. MTA NYCT will have future project modification authority and operations and maintenance responsibility.



## Project Facts

*Managing Agency:* Metropolitan Transit Authority (MTA)

*Primary Federal Funder:* U.S. Department of Transportation, Federal Transit Administration (FTA); grant funding was awarded in 2015.

*Project Status:* The 148<sup>th</sup> Street Yard portal construction started on April 2018 and is anticipated to end September 2021. The 207<sup>th</sup> Street Yard portal construction is anticipated to begin on June 2018 and end in August 2023. Conceptual design for flood mitigation at the Hugh L. Carey Tunnel is anticipated to end in December 2018.

*Project Elevation (ft NAVD88):* SLOSH Category 2 Hurricane + 3-foot safety factor based on MTA NYCT guidance. The following sites and design flood elevations were provided.

Site Name	Design Flood Elevation (DFE)/ Crest Elevation (ft., NAVD88)
148 <sup>th</sup> Street Lenox Portal	+19.1
207 <sup>th</sup> Street Portal	+18.8
Hunters Point Portal	+18.8
Consolidated Revenue Facility	+16.7
Zerega Depot	+19.5
Tiffany Storeroom	+19.2

## Areas of Reduced Risk

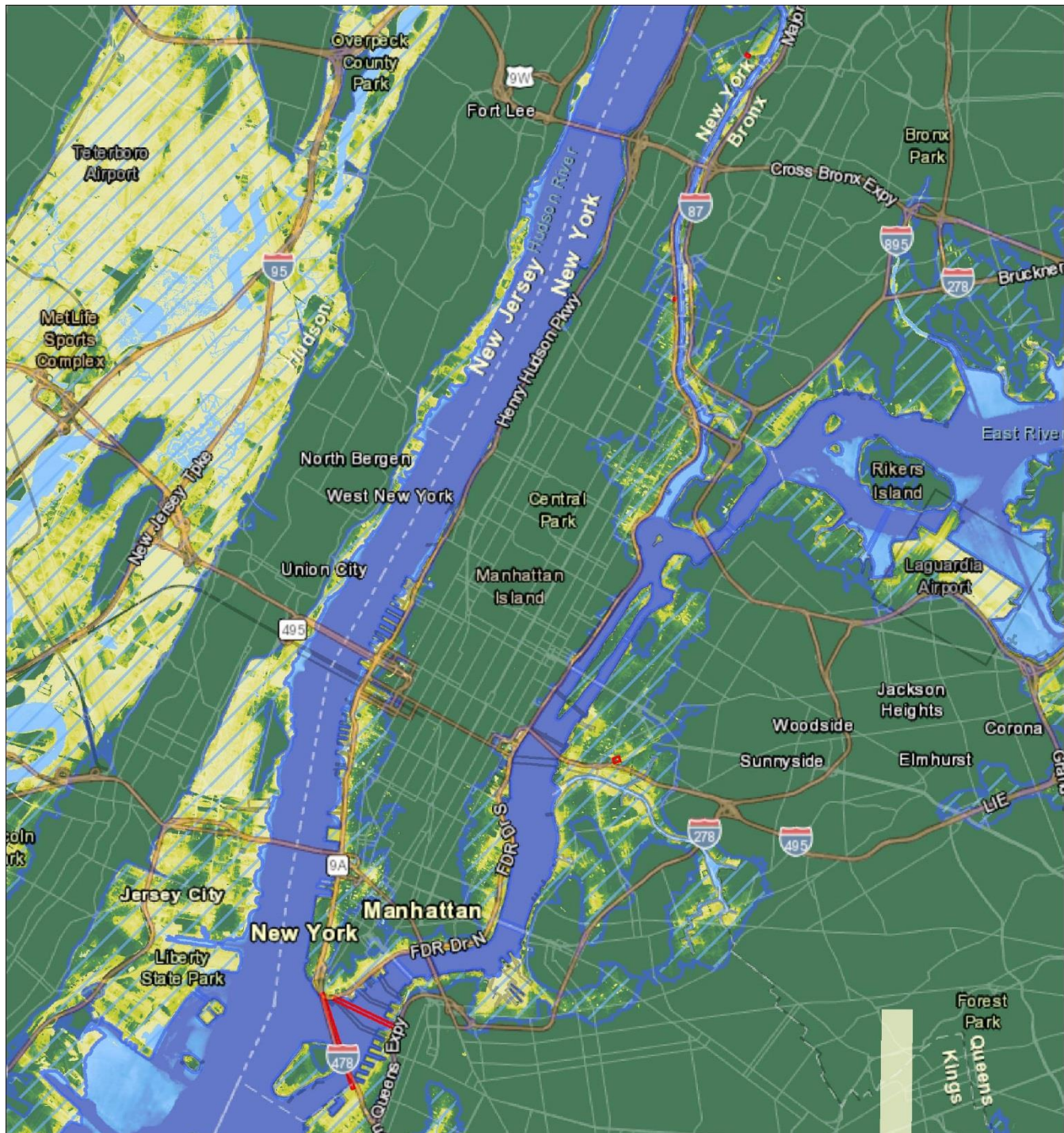
- 148<sup>th</sup> Street Portal
- 207<sup>th</sup> Street Portal
- Hunters Point
- Montague Tube
- Hugh L. Carey Tunnel

## References

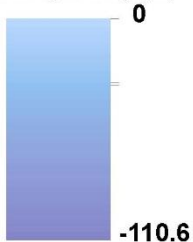
1. Dutta, P. (February 27, 2018). Personal communication.
2. Morgan, R. (June 12, 2018). Personal communication.
3. ILC Dover. (n.d.). *Portal Flex-Gate*. Available at <http://www.ilcdover.com/portal-flex-gate-1>. Accessed March 2018.
4. Metropolitan Transportation Authority (MTA). (n.d.) *MTA Climate Adaptation Task Force Resiliency Project*. Accessed January 2018. Available at <http://web.mta.info/sustainability/pdf/ResiliencyReport.pdf>.
5. MTA. Capital Program Dashboard. Accessed June 1, 2018. Available at: <http://web.mta.info/capitaldashboard/CPDHome.html?AGENCY=a&PLN=z>
6. MTA New York City Transit / Leonard Wiggins. 2012. *12. Previous Water Line at Cranberry Tube*. Accessed March 13, 2018. Available at <https://www.flickr.com/photos/mtaphotos/8149552042/>.
7. MTA / George Von Dolln. 2011. *P8271304*. Accessed March 13, 2018. Available at <https://www.flickr.com/photos/mtaphotos/6088662319/>.



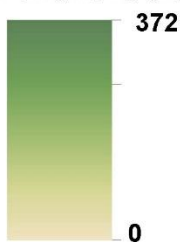




Bathymetry (ft)



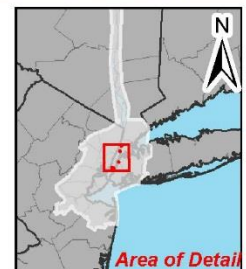
Topography (ft)



NYC Transit Tunnel  
Portals and Internal  
Tunnels

1,000 Year Flood Extent  
(0.1% annual chance)

0 1.5 3 Miles







Source: MTA / Michael Hermance



Source: MTA / Joseph Chan

## Project Description

More than 50 percent of the Hudson Line right-of-way was completely submerged during Hurricane Sandy. Power, communications, and signal systems were flooded by saltwater and significantly damaged. The storm surge damaged or destroyed fiber optic cables; signal system components such as circuit boards, racks, and relays; and communication infrastructure such as radio base stations. The purpose of this project is to 1) provide protective measures to protect vulnerable equipment (existing traction power substations/ components) and vulnerable yard locations from saltwater damage and corrosion; 2) minimize damage, if saltwater enters the systems; and 3) expedite service restoration through resilient systems/processes primarily along the Hudson Line.

## Solution

Metropolitan Transportation Authority (MTA) will reduce flood damages to the Metro-North Railroad Hudson River Line by placing its communications, power, and signal electrical components on 92 raised steel platforms along 30 miles of track to prevent damage from corrosive saltwater in the event of a storm surge. Equipment will be raised onto platforms greater than the FEMA Advisory Base Flood Elevation (ABFE), including third rail switches, cases for snowmelters, signal power transformers, and communications systems pedestals. Substations will be hardened with watertight doors. As of 2018, no permits are required for this project. Future project modification authority and operations and maintenance responsibility has not been determined.

## Areas of Reduced Risk

- **The project scope includes more than 20 locations on the eastern bank of the Hudson River, in The Bronx, and in Westchester from CP5 (Bronx) to CP35 (Croton-Harmon).**

## Project Facts

*Managing Agency:* Metropolitan Transit Authority (MTA)



**Primary Federal Funder:** U.S. Department of Transportation, Federal Transit Administration (FTA) under 49 U.S.C. Section 5324 with local match; grant pending FTA approval.

**Project Status:** Construction Phase

**Construction Agency and Status:** A third-party construction contractor has not yet been selected. The contract is expected for re-advertisement at the end of February 2018.

**Project Elevation (ft NAVD88):** Between +12 feet and +14 feet NAVD88 (see table below)

Site Name	Site Description	Design Flood Elevation (DFE)/ Crest Elevation (ft., NAVD88)
Highbridge Yard	Rail yard in the Bronx, NY with a train cleaning building and outdoor electrical equipment to be protected against flooding using new concrete walls and flood doors.	+14.0
Substation A-8 (Morris Heights)	Electrical substation building located in the Morris Heights section of the Bronx, NY. The building will be reinforced and fitted with watertight doors.	+14.0
Substation A-10 (Marble Hill)	Electrical substation building located in the Marble Hill section of the Bronx, NY. The building will be reinforced and fitted with watertight doors.	+13.5
Substation A-12 (Spuyten Duyvil)	Electrical substation building located in the Spuyten Duyvil section of the Bronx, NY. The building will be reinforced and fitted with watertight doors.	+13.0
Substation A-15 (Yonkers)	Electrical substation building located in Yonkers, NY. The building will be reinforced and fitted with watertight doors.	+13.0
Substation A-16 (Glenwood)	Electrical substation building located in Yonkers, NY. The building will be reinforced and fitted with watertight doors.	+13.0
Substation A-17 (Greystone)	Electrical substation building located in the Yonkers, NY. The building will be reinforced and fitted with watertight doors.	+13.0
Substation A-20 (Dobbs Ferry)	Electrical substation building located in Dobbs Ferry, NY. The building will be reinforced and fitted with watertight doors.	+12.0
Substation A-22 (Irvington)	Electrical substation building located in Irvington, NY. The building will be reinforced and fitted with watertight doors.	+12.0
Croton-Harmon Yard	Rail yard in Croton-on-Hudson, NY with two large maintenance buildings and outdoor electrical equipment to be protected against flooding using new concrete walls and flood doors.	+13.0
Signal Substation S-34	Electrical substation building located in Croton-on-Hudson, NY. The building will be reinforced and fitted with watertight doors.	+14.0

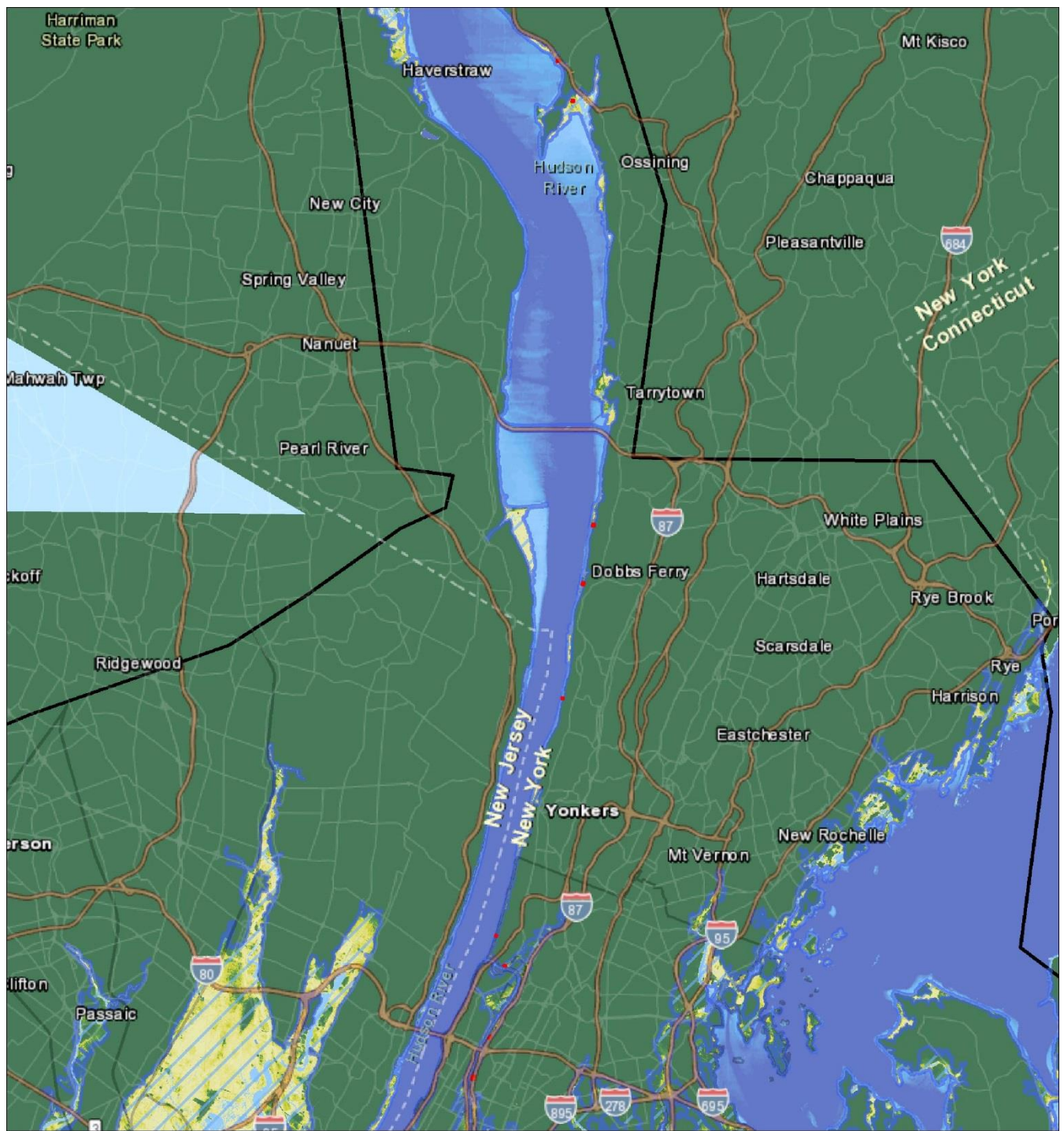


## References

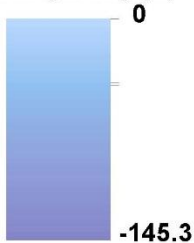
1. Dutta, P. (February 27, 2018). Personal communication.
2. O'Keefe, B. (January 12, 2018). Personal communication.
3. Metropolitan Transportation Authority (MTA). (n.d.) *MTA Announces Receipt of \$20.8 Million Federal Grant to Make Metro-North Railroad's Hudson Line Resilient Against Future Storm Surges*. Accessed November 2017. Available at <http://www.mta.info/press-release/metro-north/mta-announces-receipt-208-million-federal-grant-make-metro-north-railroad>.
4. Metropolitan Transit Authority (MTA). Capital Program Dashboard. Accessed June 1, 2018. Available at: <http://web.mta.info/capitaldashboard/CPDHome.html?AGENCY=a&PLN=Z>
5. MTA / Michael Hermance. 2011. *CP 33 007*. Accessed March 13, 2018. Available at <https://www.flickr.com/photos/mtaphotos/6088517373/>.
6. MTA / Joseph P. Chan. 2013. *Metro-North Cleanup Continues*. Accessed March 13, 2018. Available at <https://www.flickr.com/photos/mtaphotos/9336532349/>.
7. New York State. (2014). *Governor Cuomo Announces More than \$1.9 Billion in Federal Storm Resiliency Funding*. Accessed November 2017. Available at <https://www.governor.ny.gov/news/governor-cuomo-announces-more-19-billion-federal-storm-resiliency-funding>.
8. Office of Senator Charles E. Schumer. (2015). *Schumer, Gillibrand announce over \$20 million in Federal Sandy Funds for Resiliency Upgrades along Metro-North Hudson Line*. Accessed November 2017. Available at <https://www.schumer.senate.gov/newsroom/press-releases/schumer-gillibrand-announce-over-20-million-in-federal-sandy-funds-for-resiliency-upgrades-along-metro-north-hudson-line-mtas-metro-north-railroad-power-and-signal-resiliency-improvements-project-was-selected-on-competitive-basis-from-hurricane-sandy-resiliency-competition>



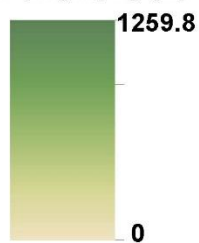




Bathymetry (ft)

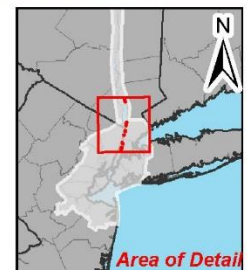


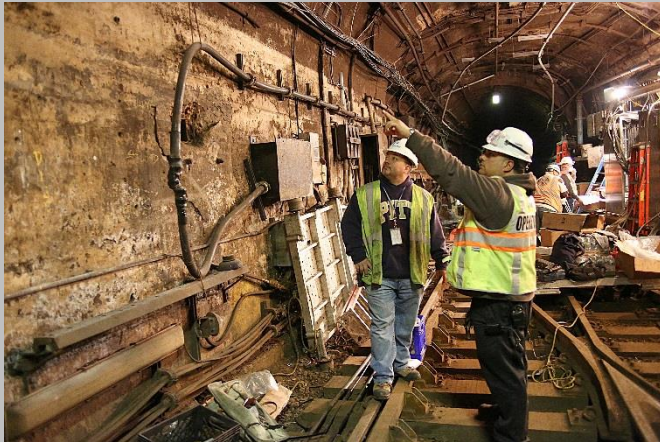
Topography (ft)



- Metro-North Power and Signal Resiliency
- 1,000 Year Flood Extent (0.1% annual chance)

0 3.5 7 Miles





Source: Adam DuBrowa/FEMA



Source: Derek Jensen

## Project Description

This project will floodproof major aboveground Port Authority Trans-Hudson (PATH) facilities and equipment to prevent flooding of underground assets in Jersey City, NJ, and improve the process for facility restart after power loss. During Hurricane Sandy, specific areas of the system affected included: Tunnels E and F between Exchange Place Station and World Trade Center (WTC) Station; Tunnels, E, F, C and D at Caisson 3; and Tunnels A, B and F at Caisson 2. Water incursion also occurred at Hoboken, Newport, Exchange Place, and Grove Street Stations and the WTC site (as shown in the project area map). Temporary flood mitigation measures were put in place at the four stations immediately following the post-storm recovery, including stop logs, water-filled barriers and sandbags.

## Solution

This project will replace temporary barriers and provide flood risk management at Exchange Place, Newport Station, and Grove Street Station. The projects are currently in planning and preliminary design, but have been authorized to construct permanent flood resiliency systems for the Exchange Place Station head houses, the Newport Station head house, and the Grove Street Station entrances to prevent flooding of underground assets.

Proposed design solutions at the PATH head house include construction of a flood wall near the water and a flood wall at the escalator, installation of side-coiling fabric barrier turnstiles and flood-rated exit doors, and reinforcement of concrete vent shafts and stair shaft walls. At PATH elevators, mitigation measures include replacement of existing stop log system, creation of a water-tight enclosure using aquarium glass, and stop logs or a flood door at the. For electrical and mechanical equipment, design solutions include elevation of generators, fuel tanks, and critical equipment, installation of sump pump systems and submersible pumps, installation of stop log systems at access points, and flow controls at sewer lines.





## Project Facts

*Managing Agency:* Port Authority of New York and New Jersey (PANYNJ)

*Primary Federal Funder:* U.S. Department of Transportation, Federal Transit Administration

*Primary Federal Funder:* U.S. Department of Transportation, Federal Transit Administration

*Project Status:* Planning and Design Phase. Starting in 2018, permanent flood protection measures will be installed.

*Project Elevation (ft NAVD88):* Elevations for example components were determined, and are subject to change:

- PATH Head House Protection = 17 ft NAVD88
- PATH elevators = 17 ft NAVD88
- Electrical and mechanical equipment = 15.3 ft NAVD88
- Substation flood protection = 17.3 ft NAVD88

## Areas of Reduced Risk

- **PATH System**
- **Exchange Place**
- **Newport Station**
- **Grove Street Station**

## References

1. DeFlorio, J. *Resilient by Design: Post-Sandy Design Guidelines and Practice at PANYNJ*. Accessed June 2018. Available at <https://ctssr.transportation.org/wp-content/uploads/sites/54/2017/11/Resilience-Guidelines-at-Port-Authority-of-New-York-and-New-Jersey.pdf>
2. FEMA. (November 27, 2013) *FEMA P-942, Appendix H - Facility-Specific Descriptions of Critical Facilities and Key Assets*. Available at [https://www.fema.gov/media-library-data/1385590865538-0c10ec4ba66e38db446a93689445ba9e/Sandy\\_MAT\\_AppH\\_508post.pdf](https://www.fema.gov/media-library-data/1385590865538-0c10ec4ba66e38db446a93689445ba9e/Sandy_MAT_AppH_508post.pdf). Accessed February 2018.
3. Federal Emergency Management Agency (FEMA). 2012. *PATH water line*. Available from <https://www.fema.gov/media-library/assets/images/67974>. Accessed February 8, 2018.
4. Jensen, Derek. 2004. *Exchange Place subway platform in Jersey City, New Jersey*. Available from <https://commons.wikimedia.org/wiki/File:Jersey-city-exchange-place-platform.jpg>. Accessed February 8, 2018.
5. Port Authority Trans-Hudson Corporation Meeting Minutes. 2017. Available at [http://corpinfo.panynj.gov/files/uploads/documents/board-meeting-information/board-minutes-contract-authorizations/PATH\\_Minutes\\_2-16-17.pdf](http://corpinfo.panynj.gov/files/uploads/documents/board-meeting-information/board-minutes-contract-authorizations/PATH_Minutes_2-16-17.pdf)
6. Port Authority of NY and NJ. (n.d.). *Path Forward: Resiliency and Recovery*. Accessed June 2018. Available at <https://www.panynj.gov/path/resiliency-recovery.html>.









Source: Thomas Basco / Port Authority of NY and NJ



Source: Thomas Basco / Port Authority of NY and NJ

## Project Description

LaGuardia Airport (LGA) is surrounded by a berm wall system designed to prevent Flushing and Bowery Bays from flooding the airport during a tidal surge. During Hurricane Sandy, unprecedented storm surge, which reached nearly 12 feet, overtopped the berm system and flooded the airport with approximately 100 million gallons of water closing the airport to aircraft, resulting in significant financial loss for the local regional economy as well as widespread transportation delays. LGA relies on an existing stormwater catch basin and drainage system that is connected to five high capacity pump houses. Floodwater inundated the pump houses and their power sources with several feet of water, rendering them temporarily inoperable. Building the berm higher is not feasible due to Federal Aviation Administration (FAA) regulations and other flight operation limitations of the airfield. Five projects throughout LGA will mitigate future flooding and increase resiliency to storm surge (as shown in the project map). Portions of the complex are located in the preliminary 1% (AE13-VE16) and 0.2% FEMA flood zones. Construction is underway and project completion is expected April 2018.

## Solution

1. Construction of a concrete floodwall, installation of a rainwater pumping system, and floodproofing of existing electrical and electronic communication systems at the West End Substation, which is critical to powering the airfield systems including pump stations.
2. Installation of flood barriers or berms, installation of a rainwater pumping system, and floodproofing of existing electrical and electronic communication systems at the West Field Lighting Vault, a building that houses critical runway and taxiway lighting systems.
3. Construction of gravity drains to supplement the airports existing drainage network. This project will install two new gravity drains to improve the ability of the airport to drain the airfield effectively and allow stormwater to discharge into Flushing Bay, consistent with current environmental requirements.





4. Rehabilitation of the airport's supervisory control and data acquisition (SCADA) system so the LGA power distribution grid enables the airport to monitor in real-time and address issues with its electrical distribution system.
5. Replacement of existing generators with larger, more efficient emergency backup generators to supply power to airside and landside operations at Marine Air Terminal, Hangar 11, Building 39, Building 84 and Pump Stations 1, 2, 3, 4, and 6.

## Project Facts

*Managing Agency:* Port Authority of New York and New Jersey (PANYNJ)

*Primary Federal Funder:* U.S. Department of Homeland Security, Federal Emergency Management Agency (FEMA)

*Authorization Agency and Status:* Port Authority Board of Commissioners

*Project Status:* Construction Phase

*Construction Agency and Status:* HNTB New York Engineering and Architecture

*Project Elevation (ft NAVD88):* The FEMA BFE at this location ranges between AE10 to VE16. Depending on the criticality of the asset and design life, the final flood protection elevation varies as shown in the table from the PANYNJ Design Guidelines Climate Resilience.

## Areas of Reduced Risk

- **LGA West Field Lighting Vault**
- **LGA West End Substation**
- **LGA Airfield**
- **LGA electrical and communication systems**

Asset Design Life	Non Critical Assets			Critical Assets		
	Code Requirement	Sea Level Rise Adjustment	Final Flood Protection Elevation	Code Requirement	Sea Level Rise Adjustment	Final Flood Protection Elevation
Up to 2020	12"	6"	FEMA 1% Elevation + 18"	24"	6"	FEMA 1% Elevation + 30"
2021-2050	12"	16"	FEMA1% Elevation + 28"	24"	16"	FEMA1% Elevation + 40"
2051-2080	12"	28"	FEMA1% Elevation + 40"	24"	28"	FEMA1% Elevation + 52"
2080+	12"	36"	FEMA1% Elevation + 48"	24"	36"	FEMA1% Elevation + 60"

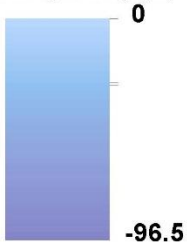
## References

1. Basco, T. (2015). *Superstorm Sandy at LaGuardia Airport: The Immediate Response and the PANYNJ's Long-Term Flood Mitigation/Storm Resilience Program*. Presented at ACI-NA CEO Forum, February 5, 2015. Available at [http://www.aci-na.org/sites/default/files/bosco-tlb\\_aci-na\\_ceo\\_forum\\_superstorm\\_sandy\\_response\\_and\\_mitigation\\_feb\\_2015.pdf](http://www.aci-na.org/sites/default/files/bosco-tlb_aci-na_ceo_forum_superstorm_sandy_response_and_mitigation_feb_2015.pdf)
2. New York State. (2013). *Governor Cuomo Announces Five Storm Mitigation and Resiliency Projects for LaGuardia Airport*. Available at <https://www.governor.ny.gov/news/governor-cuomo-announces-five-storm-mitigation-and-resiliency-projects-laguardia-airport>. Accessed November 2017.
3. Port Authority of New York and New Jersey. 2015. *Minutes from February 19, 2015 meeting*. Accessed January 2018. Available at [http://corpinfo.panynj.gov/files/uploads/documents/board-meeting-information/board-minutes-contract-authorizations/PA\\_Minutes-2-19-15.pdf](http://corpinfo.panynj.gov/files/uploads/documents/board-meeting-information/board-minutes-contract-authorizations/PA_Minutes-2-19-15.pdf).
4. Port Authority of New York and New Jersey. 2015. *Design Guidelines Climate Resilience*. Accessed June 2018. Available at <http://www.panynj.gov/business-opportunities/pdf/discipline-guidelines/climate-resilience.pdf>

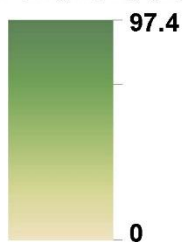




Bathymetry (ft)



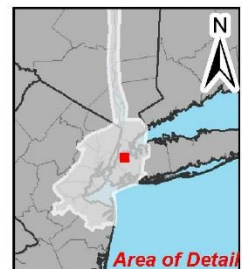
Topography (ft)



LaGuardia Airport Mitigation

1,000 Year Flood Extent (0.1% annual chance)

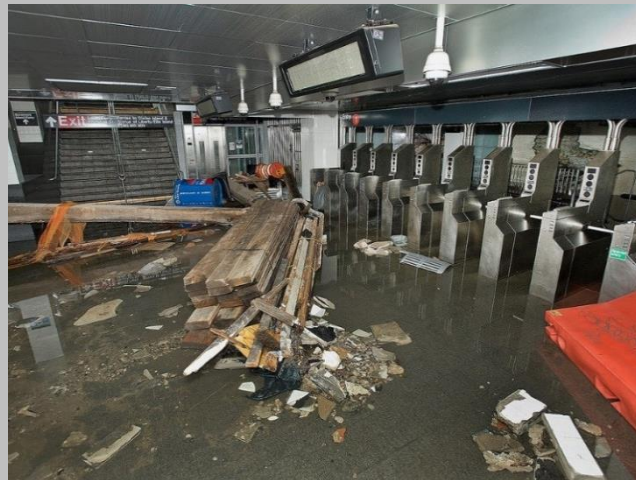
0 0.5 1 Miles







Source: MTA / Patrick Cashin



Source: MTA / Patrick Cashin

## Project Description

Metropolitan Transportation Authority (MTA) will floodproof communications and signal rooms at 20 key New York City Transit subway stations throughout the boroughs in flood hazard areas. In October 2016, the Federal Transit Administration (FTA) approved a partial reallocation of Hurricane Sandy Disaster Relief funds of this project for additional New York City Transit Hurricane Sandy recovery and resilience projects and revised the cost estimate and grant amount in January 2017. This project includes protection of critical rooms in underground and above ground stations across the transit system.

## Solution

The plan will harden infrastructure and improve network resiliency for all forms of transit in New York City. Solutions include deployable flood logs, marine doors, and reinforced walls. As of 2018, there are no applicable permits required for this project. MTA New York City Transit will have future project modification authority and operations and maintenance responsibility.

This project will install flood protection measures to protect critical facilities at various stations in Lower Manhattan that are vulnerable to flooding during a major storm event. Work may include mitigation of flooding of communication and signal rooms with water-tight doors and sealing of any opening or penetration to prevent water leakage. This project will also develop an effective flood mitigation scheme to protect stations, infrastructure and equipment from flooding conditions.

There are at least 20 key locations for proposed mitigation. Project specific locations were determined based on a limited list from the MTA dashboard. One phase of the project includes the following specific locations in Lower Manhattan: Canal Street Station on the IRT-7th Avenue line; Canal Street Station on the IND-8th Avenue line; Canal Street Station upper level on the BMT- Broadway line; Canal Street Station lower level-complex on the BMT-Broadway line; Canal Street Station-Complex on the Nassau





Loop; Canal Street Station-Complex on the Lexington Avenue line; and Franklin Street Station on the IRT- 7th Avenue line. A concurrent phase is being completed with similar efforts (e.g., mitigation of flooding of communication and signal rooms with water-tight doors and sealing of any opening or penetration to prevent water leakage) at Houston Street on the Broadway 7th Avenue line, 103 Street and 110 Street on the Lexington line.

There are other proposed locations across Manhattan, Brooklyn, and Queens that will be part of this project.

## Project Facts

*Managing Agency:* Metropolitan Transit Authority (MTA)

*Primary Federal Funder:* U.S. Department of Transportation, Federal Transit Administration (FTA); grant funding was awarded in 2015

*Project Status:* Pre-Construction Phase. Varies depending on location. For the first seven stations listed, construction is anticipated to end January 2020. For the second set of stations listed, construction is anticipated to end April 2021. There are other locations for which specific dates, spatial location, and status were not available. It is likely that the mitigation efforts at these locations are currently in design.

*Project Elevation (ft NAVD88):* Varies by location. Level of protection is determined by either SLOSH Category 2 + 3 feet or FEMA 100 year + 2 feet

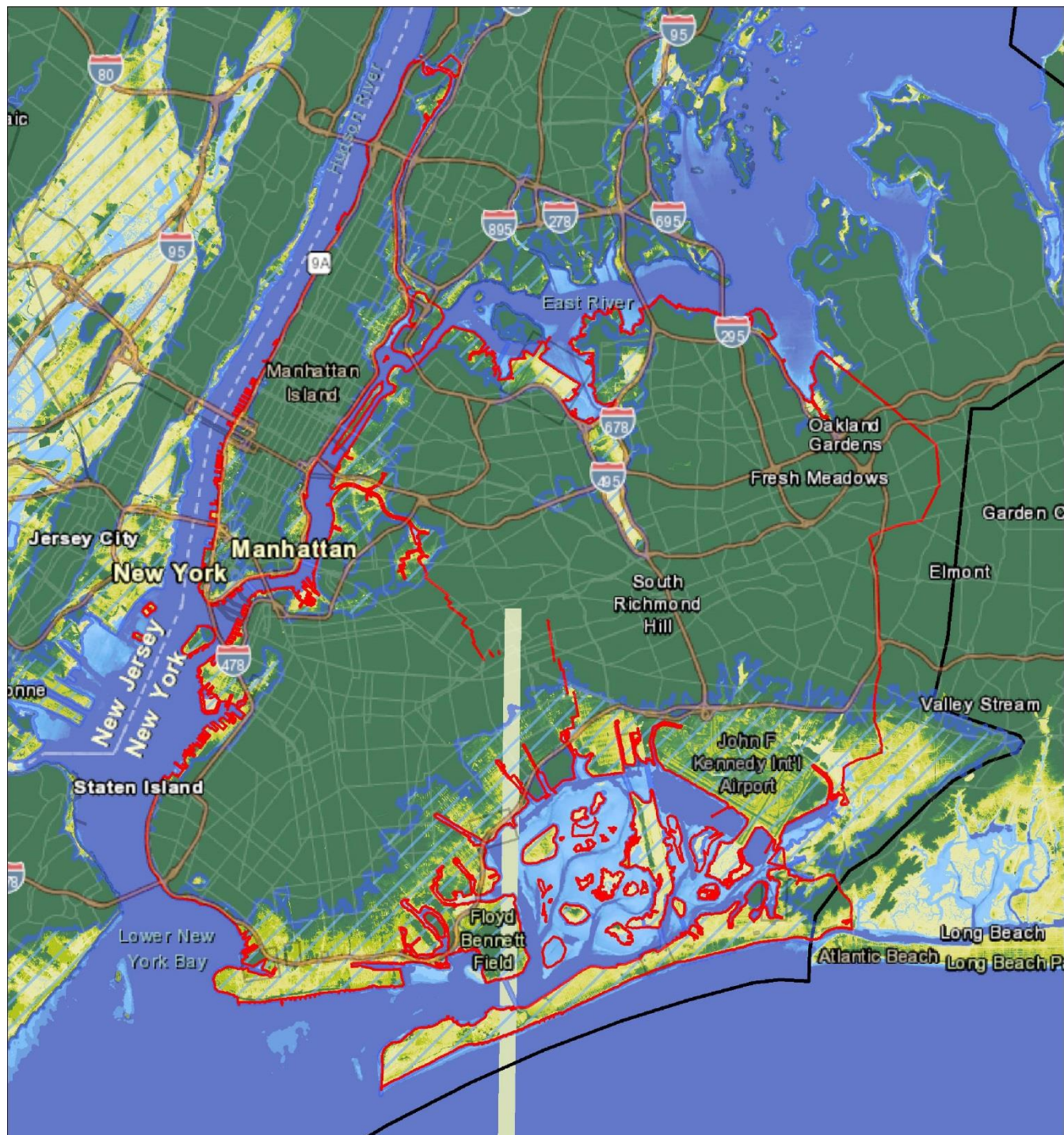
## Areas of Reduced Risk

- **20 key New York City Transit subway stations in flood hazard areas across Manhattan, Brooklyn, and Queens**

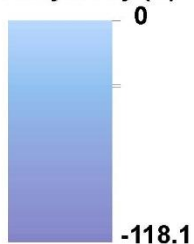
## References

1. Dutta, P. (February 27, 2018). Personal communication.
2. Metropolitan Transportation Authority (MTA) / Patrick Cashin. 2017. *Superstorm Sandy: Damage and Resiliency Work*. Accessed March 13, 2018. Available at <https://www.flickr.com/photos/mtaphotos/37918139956/>.
3. MTA. Capital Program Dashboard. Accessed June 1, 2018. Available at: <http://web.mta.info/capitaldashboard/CPDHome.html?AGENCY=a&PLN=Z>
4. MTA / Patrick Cashin. 2017. *Superstorm Sandy: Damage and Resiliency Work*. Accessed March 13, 2018. Available at <https://www.flickr.com/photos/mtaphotos/24120474828/>.
5. New York State. March 27, 2014. Governor Cuomo Unveils \$4.9 Billion Coordinated Transportation Resiliency Program. Accessed February 2018. Available at <https://www.governor.ny.gov/news/governor-cuomo-unveils-49-billion-coordinated-transportation-resiliency-program>.

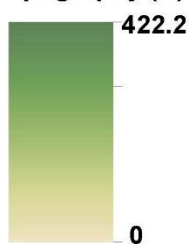




Bathymetry (ft)



Topography (ft)



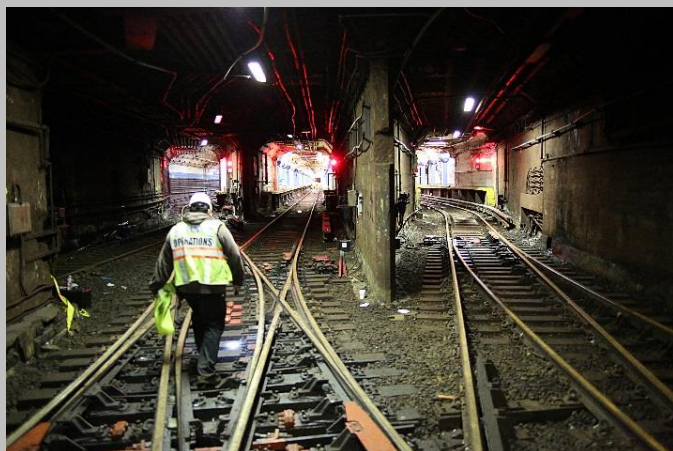
MTA Transit Internal Station Hardening

1,000 Year Flood Extent (0.1% annual chance)

0 3 6 Miles







Source: Adam DuBrowa/FEMA



Source: Sharon Karr/FEMA

## Project Description

The Port Authority of New York and New Jersey Port Authority Trans-Hudson (PATH) rapid transit system connects communities from Lower Manhattan to Bergen, Hudson, and Essex counties in New Jersey. The Newark–World Trade Center route extends from the World Trade Center to Newark Penn Station. This project will extend the route from Newark Penn Station to Newark Liberty Rail Link Station (Airport Station) at Newark Liberty International Airport (EWR). The project will improve transit access and options for PATH commuters and employees to the airport. The project also will extend transit access to the Dayton Street neighborhood, which currently has no pedestrian or bus access to Airport Station (as shown in the project map).

## Solution

Based on project alternative alignments developed to date, the project limits would intercept limited surface waters, but portions of the proposed project would be in a floodplain. An environmental assessment will evaluate potential impacts to surface water and groundwater resources, including an analysis of any floodplains and stormwater management. To expand PATH's rail storage capacity, an extension to the existing facility will be constructed outside of the 0.2% floodplain.

## Project Facts

*Managing Agency:* Port Authority of New York and New Jersey

*Primary Federal Funder:* U.S. Department of Transportation, Federal Transit Administration

*Project Status:* Planning and Pre-Construction Phase. Construction is expected to start on the extension in 2020, and completed with full revenue service operations in 2026.

### Areas of Reduced Risk

- **Proposed PATH station and rail yard**



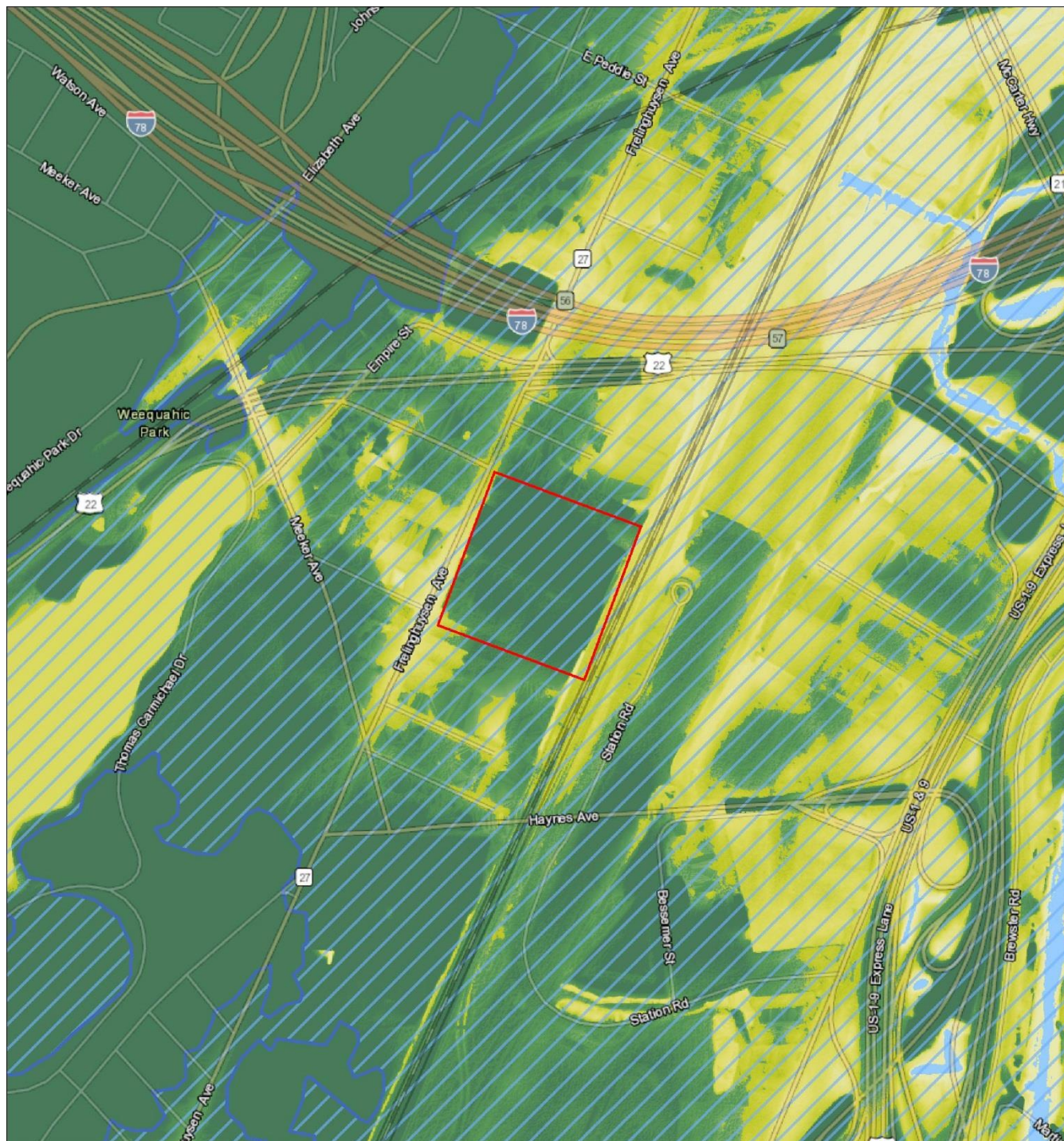


*Project Elevation (ft NAVD88):* Elevations are unknown. The facility is planned to be sited outside of the 0.2% floodplain. According to the preliminary FEMA mapping, the 0.2% flood elevation is 13.8 ft NAVD88 in Newark Bay.

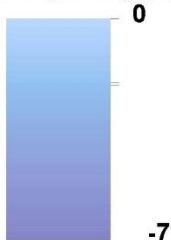
## References

1. Port Authority of New York and New Jersey. (n.d.). *PATH Extension Project*. Accessed November 2017. Available at <https://www.panynj.gov/path/path-extension.html>.
2. Port Authority of New York and New Jersey. November 2017. *PATH Extension Project Scoping Document*. Accessed February 2018. Available at [https://www.panynj.gov/path/pdf/PATH Extension Scoping Document November2017.pdf](https://www.panynj.gov/path/pdf/PATH%20Extension%20Scoping%20Document%20November2017.pdf).
3. Port Authority of New York and New Jersey. February 2017. *Capital Plan 2017-2026*. Accessed June 2018. Available at <http://corpinfo.panynj.gov/documents/Capital-Plan-2017-2026/>
4. FEMA. 2012. *Empty tracks*. Accessed February 13, 2018. Available at <https://www.fema.gov/media-library/assets/images/67973>.
5. FEMA. 2013. *Weekend Service to World Trade Center Resumes*. Accessed February 13, 2018. Available at <https://www.fema.gov/media-library/assets/images/69652>.

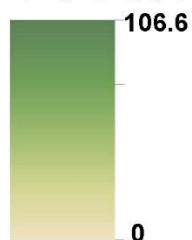




Bathymetry (ft)



Topography (ft)



Extension of PATH Rail Yards



1,000 Year Flood Extent (0.1% annual chance)

0 0.1 0.2 Miles







Source: MTA Long Island Rail Road



Source: MTA

## Project Description

Long Island Rail Road (LIRR) is highly exposed to flooding, storm surges, wind damage, and other climate variables such as extreme heat, increased precipitation, ice storms, and heavy snowfalls. Because of its extensive coastal exposures, LIRR suffered costly damage from Hurricane Sandy in 2012, including coastal flooding of the LIRR rail yard in Queens.

## Solution

The Long Island City Yard resiliency project will implement perimeter flood walls, improve drainage and stormwater management features, and elevate tracks in the south yard. This work will better protect the vital rail yard from flooding and storm surge from the East River and Newtown Creek. The final design of the perimeter flood walls is progressing and under review to provide resiliency against future flooding.

Following completion of the design, LIRR will progress to award a third-party construction contract. Power, signal, and communications systems will be replaced for the rail yard's tracks 9 through 12; tracks 7 and 8 will be electrified. Construction work for tracks 7 and 8 is underway by LIRR construction crews.

## Project Facts

*Managing Agency:* Metropolitan Transportation Authority (MTA)

*Primary Federal Funder:* U.S. Department of Transportation, Federal Transit Administration (FTA)

*Project Status:* Design of the drainage improvements ended in October 2018.

### Areas of Reduced Risk

- **The Long Island Rail Road Yard in Long Island City, Queens NY**





Construction is anticipated to end in January 2019. The construction of the floodwall is anticipated to begin in March 2019 and end in March 2021.

*Project Elevation (ft NAVD88):* The project site is located in the preliminary 1% floodplain (AE11). Detailed site-specific project and crest elevation information is not publicly available as it is still in the design phase.

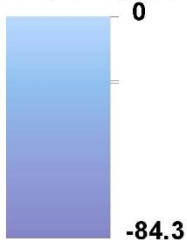
## References

1. Metropolitan Transportation Authority (MTA). (n.d.) *MTA Climate Adaptation Task Force Resiliency Project*. Available at <http://web.mta.info/sustainability/pdf/ResiliencyReport.pdf>. Accessed January 2018.
2. MTA. (n.d.) *LIRR continues to make progress post-Sandy*. Available at <http://web.mta.info/sandy/lirr.htm>. Accessed January 2018.
3. MTA Long Island Rail Road. 2012. *1910*. Accessed March 13, 2018. Available at <https://www.flickr.com/photos/mtaphotos/8139614119/>.
4. MTA. 2012. *LIRR Preps 7*. Accessed March 13, 2018. Available at <https://www.flickr.com/photos/mtaphotos/8134049464/>.
5. The City of New York. 2016. *Community Board 2 Transportation Community Meeting Minutes*. Accessed June 2018. Available at <https://www1.nyc.gov/assets/queenscb2/downloads/pdf/committee-agendas-minutes/transportation/minutes-transportation-dec2016.pdf>

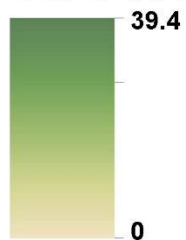




Bathymetry (ft)



Topography (ft)

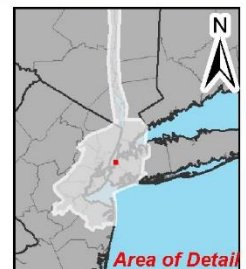


Long Island City Yard  
Resiliency



1,000 Year Flood Extent  
(0.1% annual chance)

0 0.1 0.2  
Miles







Source: MTA Capital Construction / Rehema Trimiew



Source: MTA New York City Transit / Marc A. Hermann

## Project Description

The Metropolitan Transportation Authority (MTA) New York City Transit subways are particularly vulnerable to climate change impacts, rising sea levels, and storm surges from coastal weather events. This project involves flood protections for critical underground equipment in flood risk areas throughout the New York City subway system<sup>1</sup>. These flood protection measures will make key electrical infrastructure more resilient to major storms.

## Solution

This project involves hardening of 12 pump rooms in seven under-river tubes, including elevating controls, upgrading discharge lines, and provisioning for emergency generators. This project will harden and protect critical equipment along the subway right of way in flood prone areas. Work will include pump rooms, relay rooms, signal towers and circuit breaker houses (CBHs). Schedule dates are not available, due to project being under development. As of 2018, there are no applicable permits required for this project. Metropolitan Transit Authority (MTA) New York City Transit will have future project modification authority and operations and maintenance responsibility.

### Areas of Reduced Risk

- Joralemon Tube
- Cranberry Tube
- Clark Street Tube
- Rutgers Tube
- 53 St Tube
- Steinway Tube
- Harlem River Tubes

## Project Facts

*Managing Agency:* Metropolitan Transit Authority (MTA) *Primary Federal Funder:* U.S. Department of Transportation, Federal Transit Administration (FTA); grant funding was awarded in 2015





*Project Status:* Various phases. Pump room mitigation for Joralemon and Cranberry Tubes completed in December 2017. The Clark Tube pump room mitigation construction is anticipated to end in 2019. For the Rutgers Tube, pump room construction is currently in planning, with construction anticipated to end in 2024. The Steinway Tube pump room construction was completed in November 2015. Information on the Harlem River Tubes and 53<sup>rd</sup> Street Tube were not available.

Other information related to all resiliency projects (beyond equipment hardening) to fortify the following subway tunnels are found:

Joralemon Tube: <http://web.mta.info/nyct/service/45Lines2016/index.html>

Cranberry Tube: <http://web.mta.info/nyct/service/AClines2015/index.html>

Clark Street Tube: <http://web.mta.info/nyct/service/23Lines2017/index.html>

Rutgers Tube: no website available since similar repairs are estimated to take place in 2022.

53<sup>rd</sup> Street Tube: <http://web.mta.info/nyct/service/ELine2016/>

Steinway Tube: no information available.

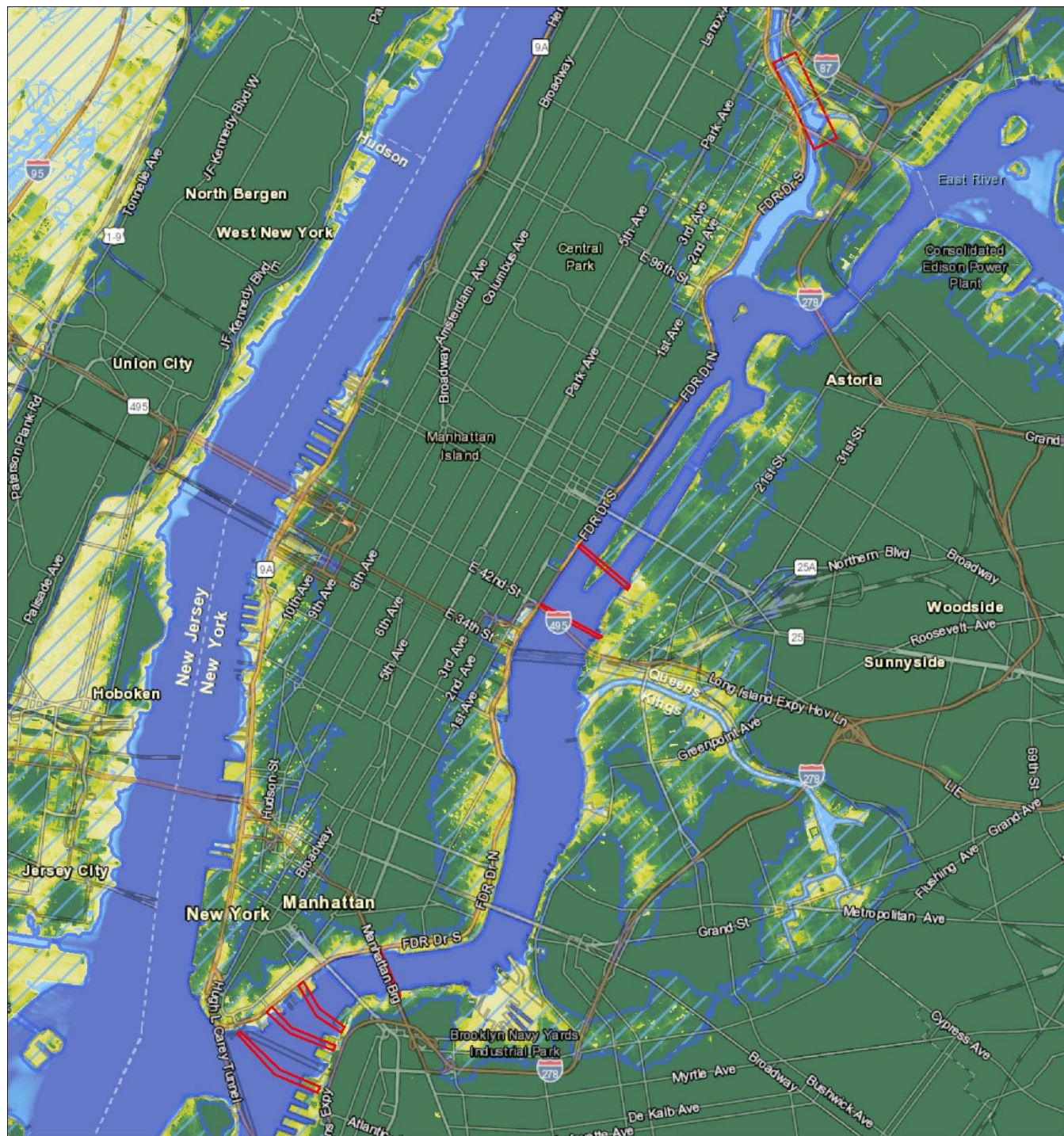
Harlem River Tubes: no information available.

*Project Elevation (ft NAVD88):* Based on MTA response, these locations are below grade.

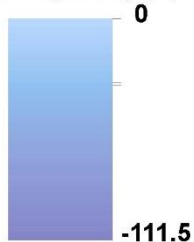
## References

1. Dutta, P. (February 27, 2018). Personal communication.
2. Federal Transit Administration (FTA). September 22, 2014. Resilience Projects in Response to Hurricane Sandy. Available at <https://www.transit.dot.gov/funding/grant-programs/emergency-relief-program/resilience-projects-responsehurricane-sandy>. Accessed November 2017.
3. MTA. Capital Program Dashboard. Accessed June 1, 2018. Available at: <http://web.mta.info/capitaldashboard/CPDHome.html?AGENCY=a&PLN=Z>
4. MTA Capital Construction / Rehema Trimiew. 2015. *Second Avenue Subway Update: January and February 2015*. Accessed March 13, 2018. Available at <https://www.flickr.com/photos/mtaphotos/16451874119/>.
5. MTA / Marc A. Hermann. 2014. *Nostalgia Trains Mark Subways' 110th Anniversary*. Accessed March 13, 2018. Available at <https://www.flickr.com/photos/mtaphotos/15617825196/>.

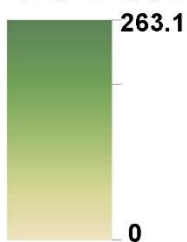




Bathymetry (ft)



Topography (ft)



NYC Transit Right-of-Way Equipment Hardening

1,000 Year Flood Extent (0.1% annual chance)

0 1 2 Miles







New Dorp Beach, Staten Island (Source: NYCEDC)

## Project Description

The Raised Shorelines Citywide program is an innovative program that aims to elevate City coastlines most vulnerable to Sea Level Rise. The City completed a vulnerability assessment of all 520 miles of City coastline in 2016. This assessment identified vulnerable areas based on risk to high tide inundation in the 2050s and then developed benefit-cost indices for the projects based on a number of factors including social vulnerability and critical infrastructure.

The Raised Shorelines program goals are to ensure long-term livability and security of vulnerable neighborhoods by addressing 2050s high tide inundation. In the near-term, these projects will also help mitigate low-impact high-frequency coastal flood events.

## Solution

The Raised Shoreline program will raise bulkheads and build other shoreline structures to lessen inland tidal flooding in several low-lying neighborhoods. If all projects identified in the Raised Shorelines report were to be constructed, the following benefits would be realized:

- Reducing residential property damage by at least \$300 million for approximately 1,750 households
- Mitigating economic impacts to about 1,500 jobs





- Preserving least \$15 million in revenue for no fewer than 65 businesses
- Creating or improving access to 35 acres of public space
- Providing at least \$2.5 million in ecological benefits

## Project Facts

*Managing Agency:* New York City Economic Development Corporation

*Primary Federal Funder:* U.S. Department of Housing and Urban Development (HUD)

*Project Status:* Varies, site dependent

*Project Elevation (ft NAVD88):* Varies, site dependent

## Areas of Reduced Risk

### Potential Implementation Locations (First Phase):

- Edgemere, Queens
- Old Howard Beach, Queens
- Motts Basin, Queens
- Coney Island Creek, Brooklyn
- Travis Avenue, Staten Island
- South Shore of Staten Island

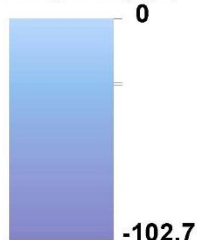
## References

1. Official Website of NYC. (2016). *Mayor de Blasio Announces Progress on New Coastal Resiliency Efforts in Most Vulnerable Communities*. Available at <http://www1.nyc.gov/office-of-the-mayor/news/370-16/onenyc-mayor-de-blasio-progress-new-coastal-resiliency-efforts-most-vulnerable>. Accessed November 2017.
2. NYC Community Development Block Grant Disaster Recovery (2017). *Summary of CDBG-DR Action Plan Allocations (in '000s)*. Available at <http://www1.nyc.gov/site/cdbgr/action-plan/allocations.page>. Accessed January 2018.
3. NYCEDC. (2016). *Raising Shorelines Citywide Information Session*. Available at <https://www.nycedc.com/sites/default/files/files/rfp/qa-documents/Raise%20Shorelines%20Design%20RFP%20Presentation.pdf> Accessed November 2017.
4. NYC Housing Preservation and Development (2017). *Resilient Edgemere Community Plan*. Available at <http://www1.nyc.gov/site/hpd/community/Edgemere.page> Accessed January 2018.
5. FEMA. 2013. *Sand is Back at The Beach*. Available at <https://www.fema.gov/media-library/assets/images/68639>.
6. FEMA. 2013. *Long Beach Boardwalk Completed Ahead of Schedule and Under Budget*. Available at <https://www.fema.gov/media-library/assets/images/85133>.

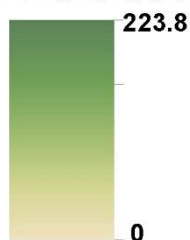




Bathymetry (ft)



Topography (ft)



NYC Raised Shorelines



1,000 Year Flood Extent  
(0.1% annual chance)

0 1.5 3 Miles







Source: FEMA



Source: FEMA

## Project Description

The Passaic Valley Sewerage Commission (PVSC) Newark Bay Treatment Plant in Newark, NJ, treats wastewater and treatment sludge from 3.43 million customers<sup>1</sup>. The treatment plant accounts for approximately 25% of all wastewater treatment in New Jersey and 15% of all wastewater treatment in New York City.

Located on low-lying ground near Newark Bay, the treatment plant is vulnerable to coastal flooding. Floodwaters during Hurricane Sandy inundated the treatment plant, causing an estimated \$200 million in damages to various pieces of equipment, and a power outage caused untreated sewage to discharge into Newark Bay preventing raw sewage from backing up in homes and businesses.

## Solution

To prevent future emergencies from coastal flooding and to increase the plant's resiliency, PVSC proposed mitigations and updates to the treatment plant and received public assistance funding from a Federal Emergency Management Agency (FEMA) Section 406 mitigation funding grant. The overall project is being implemented by a series of construction project as follows.

Specific improvements include:

- *Plantwide replacement and relocation of electrical switchgear, motor control centers, and appurtenances.* This contract will elevate electrical equipment from the lower levels of the plant to upper levels to avoid future flooding should it occur. The construction contract was awarded to Tomar Construction and will begin in January 2018.
- *Plantwide cable replacement and utility bulkheads.* This contract will relocate previously elevated high voltage electrical lines back into the utility tunnels and will construct utility bulkheads to isolate damage should future flooding occur. The bidding of the project is anticipated in the first quarter of 2018.
- *Construction of two perimeter flood walls for the east and west portion of the plant.* Design is underway by the Joint Venture of STV Inc. and Mott MacDonald and approximately 60% complete. The bidding of the project is anticipated in the fourth quarter of 2018.
- *Construction of a 36 megawatt standby power generating station.* Final approvals for a site preparation contract and equipment procurement contract are currently being finalized. Final design will begin upon selection of appropriate equipment. The construction of the main contract is anticipated to occur starting in mid-2019.





- *Construction of stormwater pumping stations.* Three stormwater pumping stations will pump out any collected stormwater from within the limits of the floodwall. Design is approximately 30% complete. This bidding of this project is anticipated in late 2018 with award in early 2019. It is anticipated that construction period will be two years.
- *Construction of stormwater collection systems.* Additional improvements are needed to the existing collection system to convey stormwater to the new pumping stations and to provide capacity to convey flows generated by a 100-year recurrence event. This bidding of this contract is anticipated in early 2019.
- *Advanced electrical contract.* Improvements to the electrical distribution system are necessary to provide connections to the pumping station and power plant facilities. Construction details are not currently available.

## Project Facts

*Managing Agency:* State of New Jersey, Passaic Valley Sewerage Commission

*Primary Federal Funder:* FEMA

*Project Status:* Construction Phase

*Construction Agency and Status:* Various

*Project Elevation (ft NAVD88):* Facilities are designed for 19-21 ft NAVD88 depending upon the location

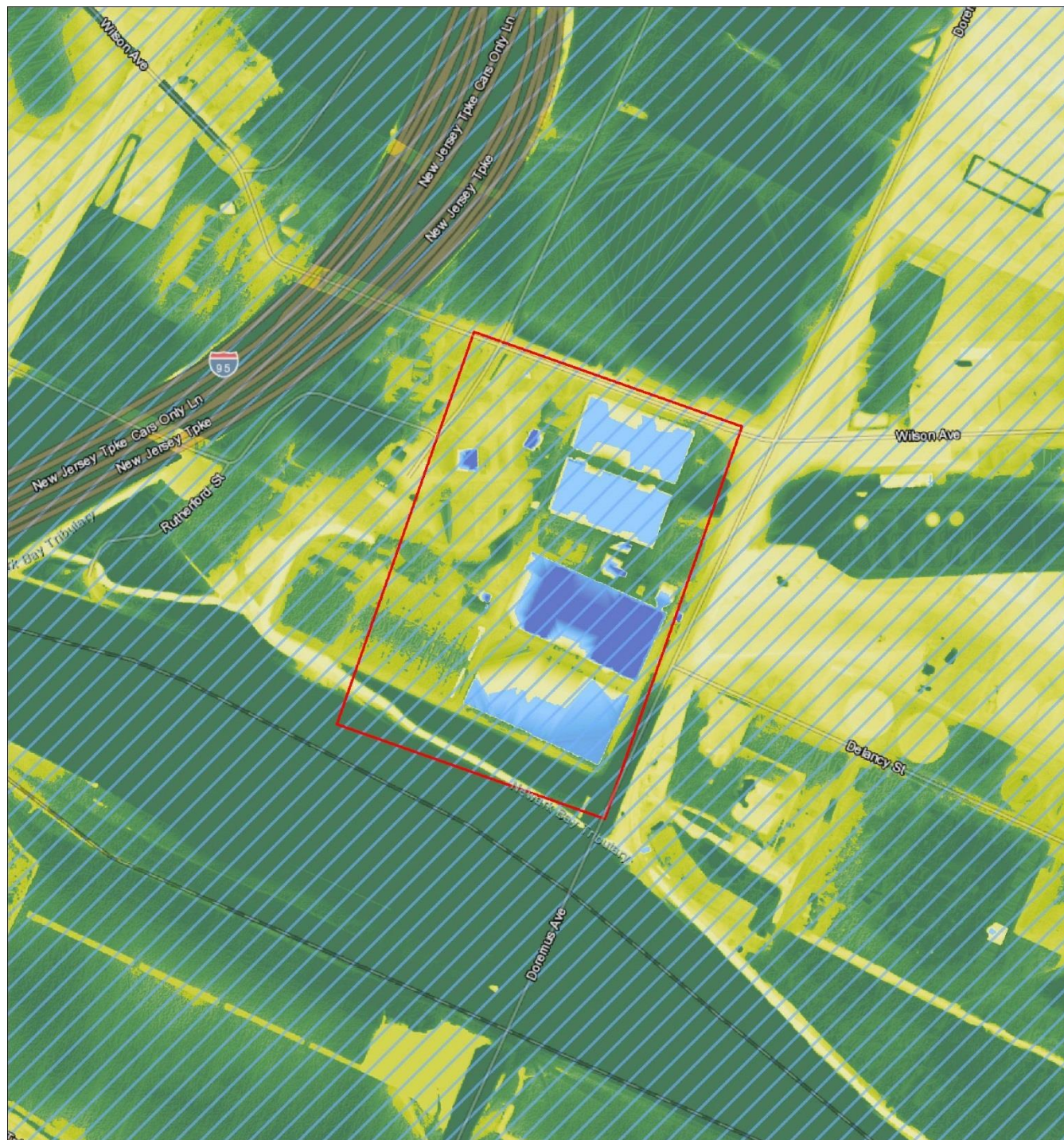
## Areas of Reduced Risk

- **PVSC Newark Bay Treatment Plant, Newark NJ**

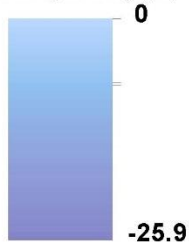
## References

1. FEMA. (2015). *Three Years After Sandy: Recovery and Resiliency at Passaic Valley Sewerage Commission*. Available at <https://www.fema.gov/news-release/2015/10/09/three-years-after-sandy-recovery-and-resiliency-passaic-valley-sewerage>. Accessed November 2017.
2. FEMA. (2015). *Three Years after Sandy: Recovery and Resiliency at Passaic Valley Sewerage Commission*. Available from <https://www.fema.gov/news-release/2015/10/09/three-years-after-sandy-recovery-and-resiliency-passaic-valley-sewerage>
3. J. Rotolo (personal communication, December 21, 2017). Project Information Request for USACE New York New Jersey Harbor and Tributaries Study

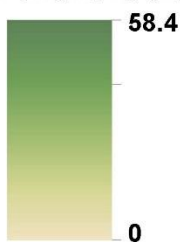




Bathymetry (ft)



Topography (ft)



Passaic Valley Sewerage Commission



1,000 Year Flood Extent (0.1% annual chance)

0 0.1 0.2 Miles







Source: Kenneth Wilsey/FEMA



Source: Kenneth Wilsey/FEMA

## Project Description

New York University (NYU) Langone Medical Center is vulnerable to flooding because of its location on the banks of the East River in Manhattan (as shown in the project area map). The center had significant flooding in 2012 during Hurricane Sandy, causing the evacuation and temporary closure of the center. The damaged facility is located within the 1% and 0.2% annual chance floodplains and subject to repetitive flooding from the coastal floodplain. The FEMA preliminary mapping shows the 1% annual chance floodplain encompassing approximately half of the entire campus.

The floodwater-damaged medical equipment and components of the center's heating, ventilation, and air conditioning (HVAC) and power generation networks. The center was granted Federal Emergency Management Agency (FEMA) Section 428 Alternative Public Assistance Program funding to replace equipment and components, repair and restore mechanical and electrical systems at 14 damaged facilities, and upgrade exterior and interior floodproofing measures.

## Solution

Specific improvements include:

- Constructing an integrated dry floodproofing barrier, including installing exterior flood barrier, wall and slab reinforcements, fill-in areaways and enclosing exterior penetrations. Flood barriers are employed to bridge the gaps between buildings and where the flood barrier is not part of the building structural wall system.
- Compartmentalizing and elevating critical systems, including elevating mechanical, electric and piping (MEP) systems and equipment and installing interior flood doors, penetration seals, check valve/backflow preventers, and sump pumps.

The project is scheduled for completion in August 2021<sup>1</sup>.

## Project Facts

*Managing Agency:* New York University School of Medicine

*Primary Federal Funder:* U.S. Department of Homeland Security, Federal Emergency Management Agency

*Project Status:* Construction Phase anticipated to be completed by August 2021.

## Areas of Reduced Risk

- **NYU Langone Medical Center**



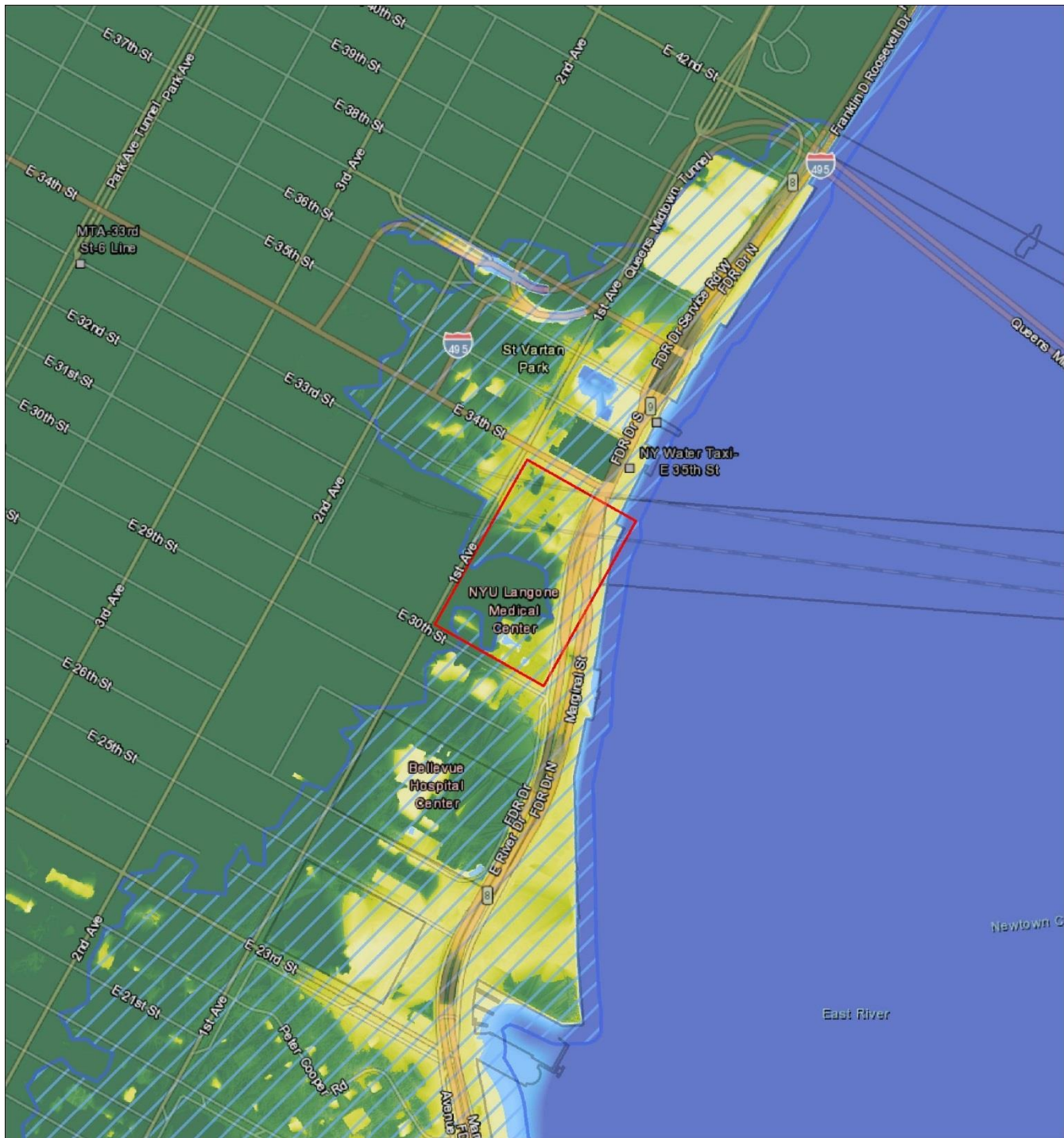


*Project Elevation (ft NAVD88):* Risk reduction beyond the 0.2% advisory base flood elevation (16 ft NAVD88). The design flood elevation is reported to be 15.35 to 16.35 ft NAVD88. Estimated height of the floodwall system is 12 feet above ground surface.

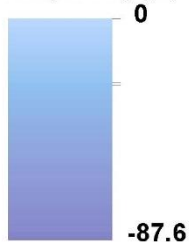
## References

1. FEMA. 2017. *NYU Langone Medical Center*. Available at <https://www.fema.gov/nyu-langone-medical-center>. Accessed November 2017.
2. FEMA. 2017. *NYU Langone Medical Center Facility Construction Environmental Assessment*. Available at [https://www.fema.gov/media-library-data/20130726-1921-25045-5827/20130701\\_nyulmc\\_ea.pdf](https://www.fema.gov/media-library-data/20130726-1921-25045-5827/20130701_nyulmc_ea.pdf). Accessed November 2017.
3. FEMA. 2014. *NYU Medical Center Is Planning Flood Protection for Its Facilities*. Available at <https://www.fema.gov/media-library/assets/images/92590>
4. FEMA. 2014. *NYU Medical Center Is Planning Flood Protection for Its Facilities*. Available at <https://www.fema.gov/media-library/assets/images/92592>
5. Suna, V., P. Schwabacher, D. Tepper. 2013. *Planning for the Future in a Changing Environment*. State of New York Public Health and Health Planning Council. Accessed June 2018. Available at [https://www.health.ny.gov/facilities/public\\_health\\_and\\_health\\_planning\\_council/meetings/2013-06-27/docs/nyu\\_langone.pdf](https://www.health.ny.gov/facilities/public_health_and_health_planning_council/meetings/2013-06-27/docs/nyu_langone.pdf)





Bathymetry (ft)



Topography (ft)



  NYU Langone Medical Center

  1,000 Year Flood Extent (0.1% annual chance)

0 0.1 0.2 Miles





Source: MTA / Patrick Cashin



Source: MTA / Patrick Cashin

## Project Description

The 207th Street Rail Yard, located on the banks of the Harlem River, is at risk of flooding during extreme weather events. The 207th Street Rail Yard covers 43 acres and has 10 miles of storage tracks and several shop buildings, including the New York City Transit subway system's primary car maintenance shop. In addition to Metropolitan Transportation Authority (MTA) services, the 207th Street Rail Yard contains garbage processing facilities that serve all communities within Manhattan and The Bronx. To keep the rail yard resilient long term, several updates and floodproofing measures have been designed by HDR Consultants. The planned work includes construction of floodproof sea walls, a perimeter floodwall, various flood barriers, improved drainage, improved pumping capacity, and hardening measures.

## Solution

Specific improvements to the 207th Street Rail Yard will provide continued MTA transit service with minimized disruption during and after extreme weather events. Project work aims to protect all assets stored temporarily and permanently at the rail yard and will protect tunnel portals onsite from flooding. Proposed flood mitigation and resiliency measures include:

- Installation of new and improvement of existing perimeter floodwalls surrounding the property
- Installation of temporary flood gates at all yard entrances
- Installation of temporary flood barriers at the 8th Avenue tunnel portal
- Stormwater drainage improvements

## Project Facts

*Managing Agency:* Metropolitan Transportation Authority (MTA)

*Primary Federal Funder:* U.S. Department of Transportation, Federal Transit Authority (FTA)

*Project Status:* Construction is anticipated to start June 2018 and end August of 2023.

*Project Elevation (ft NAVD88):* Perimeter design crest elevation is 18.8 feet NAVD88, which varies between 8 to 12 feet high floodwalls or swing gates.

### Areas of Reduced Risk

- 207th Street Rail Yard, Manhattan
- 8th Avenue Tunnel Portal

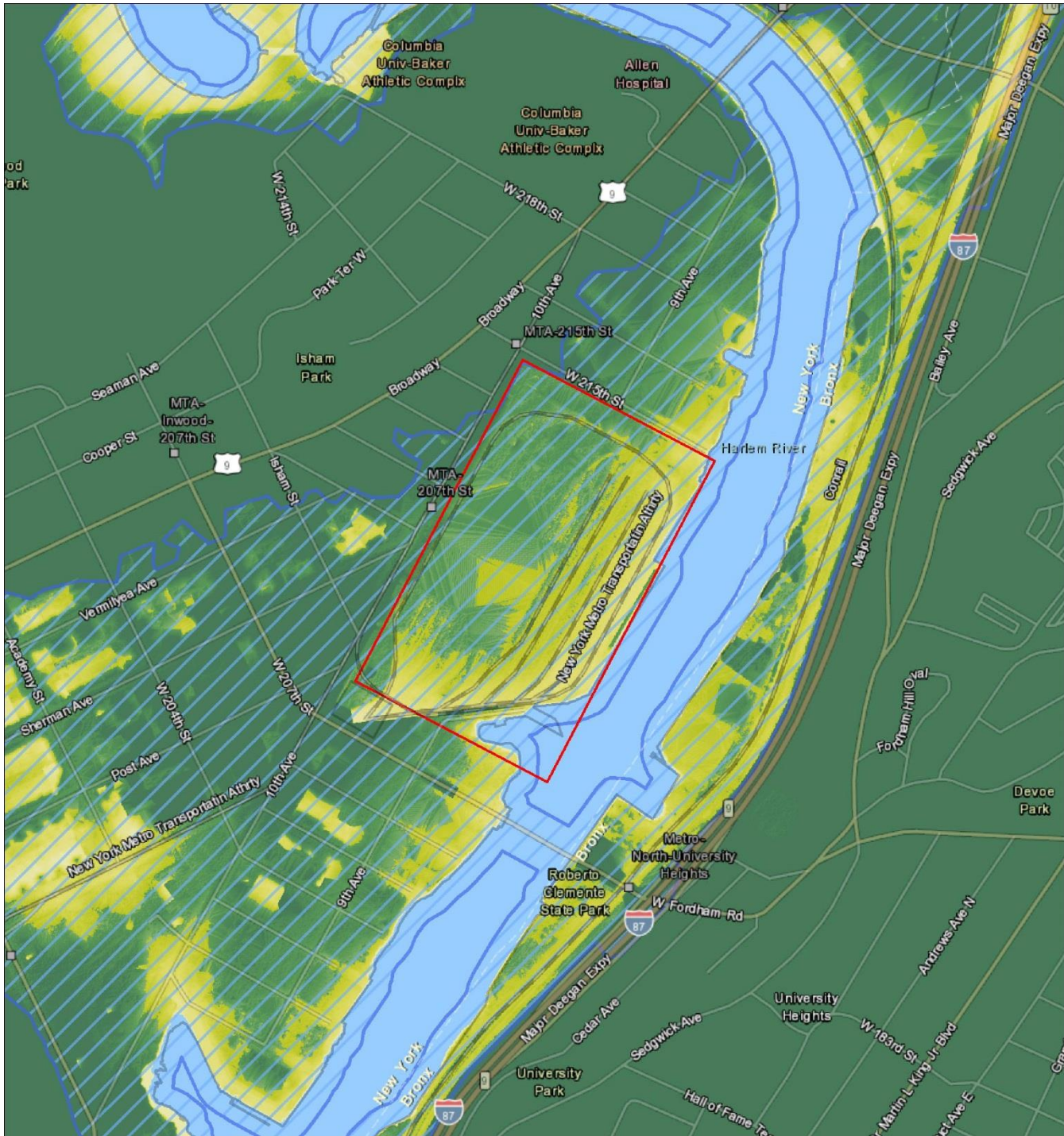




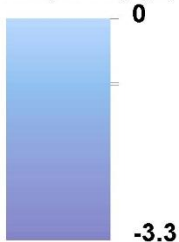
## References

1. HDR. (November 1 – 2, 2016). *Sandy Raises the Yards – Permitting Raises the NEPA Bar: MTA-NYCT 207<sup>th</sup> St Yard Flood Mitigation/Resiliency Project*. Powerpoint presented at Environmental Railroad Conference. Accessed January 2018. Available at [http://railtec.illinois.edu/RREC/pdf/2016%20RREC/Presentations/40\\_Gillespie.pdf](http://railtec.illinois.edu/RREC/pdf/2016%20RREC/Presentations/40_Gillespie.pdf).
2. Metropolitan Transportation Authority (MTA) / Patrick Cashin. 2013. *Scheduled Maintenance System at Coney Island Yard*. Accessed March 13, 2018. Available at <https://www.flickr.com/photos/mtaphotos/9689838890/>.
3. MTA / Patrick Cashin. 2013. *7Line\_2077*. Accessed March 13, 2018. Available at <https://www.flickr.com/photos/mtaphotos/9124956017/>.
4. MTA. Capital Program Dashboard. Accessed June 1, 2018. Available at: <http://web.mta.info/capitaldashboard/CPDHome.html?AGENCY=a&PLN=Z>

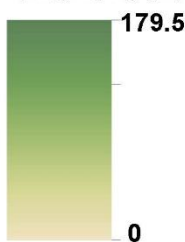




Bathymetry (ft)



Topography (ft)



- 207th Street Rail Yard
- 1,000 Year Flood Extent (0.1% annual chance)

0 0.1 0.2 Miles







Source: Kenneth Wilsey/FEMA



Source: Kenneth Wilsey/FEMA

## Project Description

The Veterans Affairs Medical Center (VAMC) Manhattan campus is located near the banks of the East River in Manhattan, NY (as shown in the project area map). The campus is located within FEMA-designated 1% annual chance floodplain. The facility experienced significant flooding and damage during Hurricane Sandy in 2012, which led to evacuation and temporary closure of the facility in the aftermath of the hurricane.

The New York Harbor Healthcare System project was designed in response to Hurricane Sandy to address flooding problems at the Manhattan campus. The purpose of this project is to increase resiliency of the facility during extreme weather events through construction of various flood protection measures.

## Solution

This project includes constructing a floodwall and seepage cutoff wall, making interior drainage improvements, constructing four sanitary sewer pumping stations, performing interior site paving, performing utility service reconstruction, constructing manholes, installation of backflow prevention valves, and landscaping. T

he floodwall will traverse from the main building entrance at 1<sup>st</sup> Avenue and 23<sup>rd</sup> Street, east to Asser Levy Place, north along Asser Levy, and then west along 25<sup>th</sup> Street. The total length of the floodwall will be approximately 1,570 feet. The height of the floodwall is 10 to 10.5 feet above ground along the Asser Levy Playground, and at least 8 feet above grade along East 23<sup>rd</sup> and East 25<sup>th</sup> Streets. Five flood gates will be deployed around the perimeter of the site which will allow vehicle and pedestrian access to the site, while allowing closure of openings in the event of a coastal flooding event.

## Project Facts

*Managing Agency:* Department of Veterans Affairs New York Harbor Healthcare System

*Primary Federal Funder:* U.S. Department of Veterans Affairs

*Project Status:* Construction Phase began in 2015 and is anticipated to end in 2018.

### Areas of Reduced Risk

- **Veterans Affairs Medical Center (VAMC), Manhattan, NY**



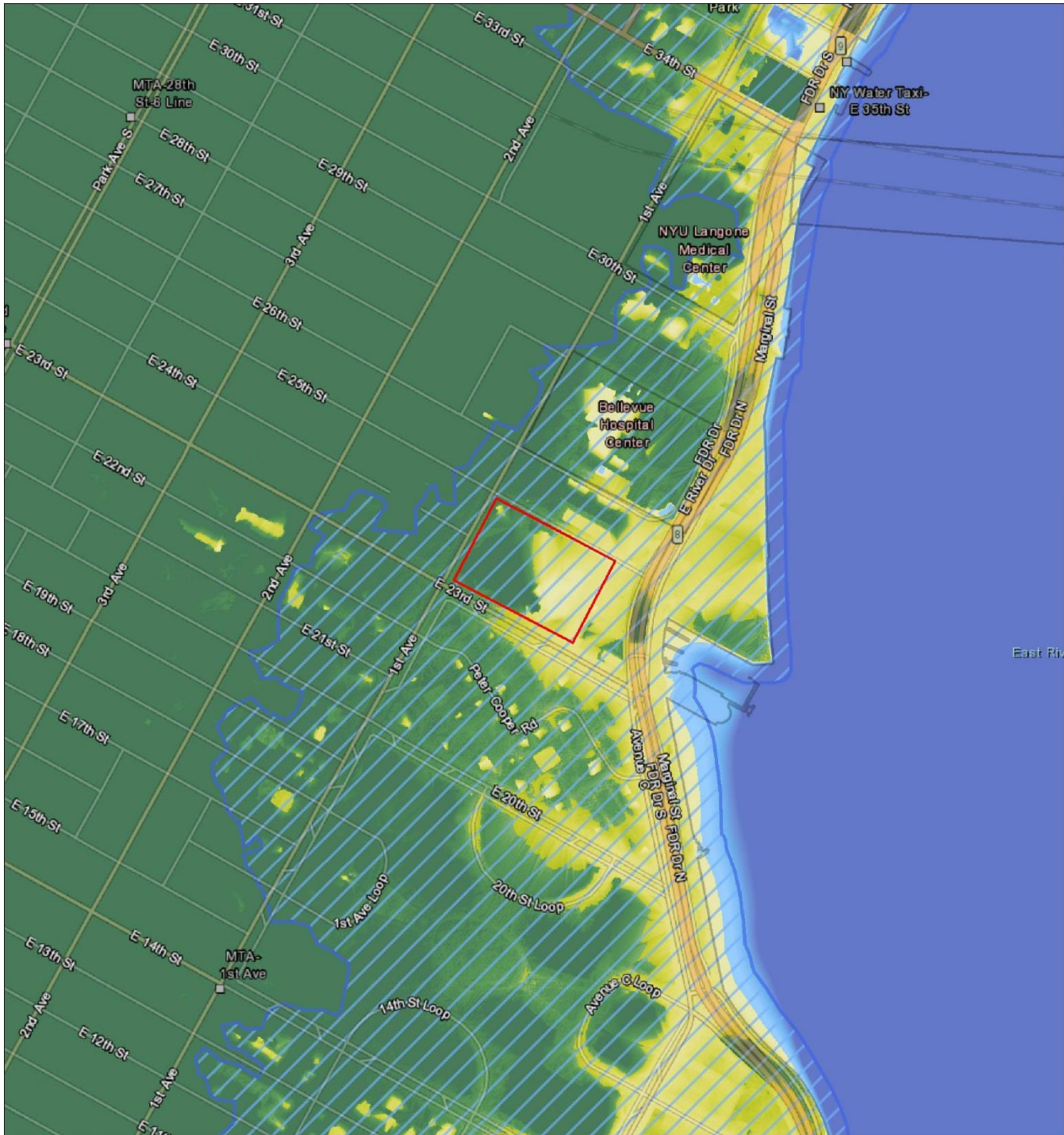


*Project Elevation (ft NAVD88):* Based on the environmental assessment, the design elevation is described as 14.5 feet above sea level (Manhattan datum). Completing the conversion to NAVD88, the elevation is 16.2 feet. The environmental assessment states that the proposed system is designed to resist the 1% annual chance flood elevation (stillwater elevation plus design height and 1 ft of freeboard) and from the 0.2% annual chance flood (stillwater elevation plus 2 ft of freeboard).

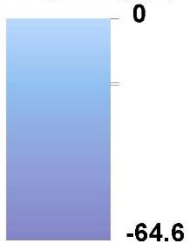
## References

1. HDR. (2014). *Draft Environmental Assessment Addressing Construction and Operation of a Floodwall at the Veterans Affairs Medical Center, Manhattan, New York*. Accessed November 2017. Available at <https://www.nyharbor.va.gov/docs/EADraft.pdf>.
2. Reddington, M. 2014. HDR. "VAMC Floodwall Protection Project." Presented at Association of State Floodplain Managers 2014. Accessed June 2018. Available at [http://www.floods.org/Files/Conf2014\\_ppts/A4\\_Reddington.pdf](http://www.floods.org/Files/Conf2014_ppts/A4_Reddington.pdf)
3. FEMA. 2014. *Veteran Administration Medical Center Is Planning Flood Protection for Its Facilities*. Accessed February 13, 2018. Available at <https://www.fema.gov/media-library/assets/images/92595>.
4. FEMA. 2014. *Hospitals on The East River In New York Are Planning Flood Protection for Their Facilities*. Accessed February 13, 2018. Available at <https://www.fema.gov/media-library/assets/images/92591>.

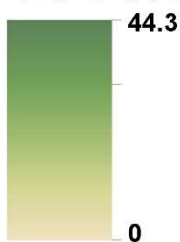




Bathymetry (ft)



Topography (ft)

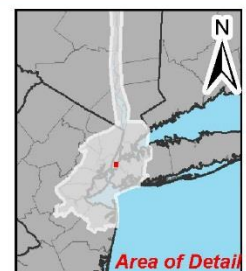


Veterans Affairs Medical Center (VAMC)



1,000 Year Flood Extent (0.1% annual chance)

0 0.1 0.2 Miles





## Project Description

The Long Slip Canal is a 2,000-foot former freight barge canal located next to the Hoboken Terminal Yard in Jersey City, NJ<sup>1</sup>. The canal was a major flooding source during Hurricane Sandy in 2012 and represents a continued flooding risk to Hoboken Yard for future events. Hoboken Yard is a multi-modal transportation hub and significant asset to the NJ Transit system.

Work performed for this project includes the filling of the Long Slip Canal and construction of additional flood-proof facilities on the filled area. The project will allow continued operation of commuter rail services to and from Hoboken Yard and its associated Hudson Bergen Light Rail, Port Authority Trans-Hudson (PATH), and ferry services when the main yard infrastructure and equipment is taken out of service for an impending storm, or is being restored to service following a storm event.

## Solution

Through the FTA's Emergency Relief Program, NJ Transit has proposed updates to the area to prevent future emergencies from coastal flooding and to increase resiliency of the terminal. Specific improvements include:

- Elimination of the former freight barge canal,
- Elevation of filled land above FEMA 1% annual chance base flood elevation,
- Construction of six new tracks,
- New track extensions,
- Additional passenger platforms
- A new passenger station/crew facility, and
- A passenger walkway connecting the new facility.

## Project Facts

*Managing Agency:* NJ Transit

*Primary Federal Funder:* U.S. Federal Transit Authority

*Project Status:* Pre-Construction Phase. This project is anticipated to end November 2022.

*Project Elevation (ft NAVD88):* The design fill elevation of the canal is approximately 12 ft NAVD88. The top of the rail system is required to meet 14.5 feet NAVD88 as per NJ Transit Flood Elevation Design Criteria.

### Areas of Reduced Risk

- Hoboken Yard, Jersey City, NJ
- NJ Transit Commuter Rail System
- Southwest corner of Hoboken, NJ





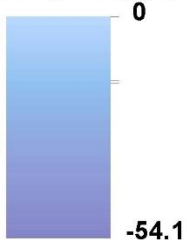
## References

1. Federal Transit Administration and New Jersey Transit Corporation. (2016). *Long Slip Fill and Rail Enhancement Project Supplemental Environmental Assessment*. Accessed June 2018. Available at [http://njtransitresilienceprogram.com/wp-content/uploads/2016/06/Long-Slip-Supplemental-EA\\_June2016\\_FINAL.pdf](http://njtransitresilienceprogram.com/wp-content/uploads/2016/06/Long-Slip-Supplemental-EA_June2016_FINAL.pdf)
2. NJ Transit. (n.d.). *Long Slip Fill and Rail Enhancement Overview*. Accessed November 2017. Available at <http://njtransitresilienceprogram.com/long-slip-overview/>.
3. State of New Jersey. (2017). "FY 2017 Major Status Project." Accessed June 2018. Available at <https://www.state.nj.us/transportation/capital/stip1827/sec11/pdf/transit.pdf>

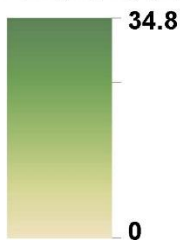




Bathymetry (ft)



Topography (ft)

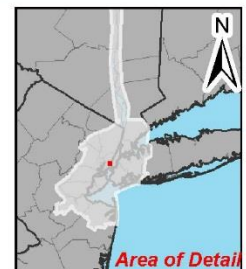


Long Slip Canal

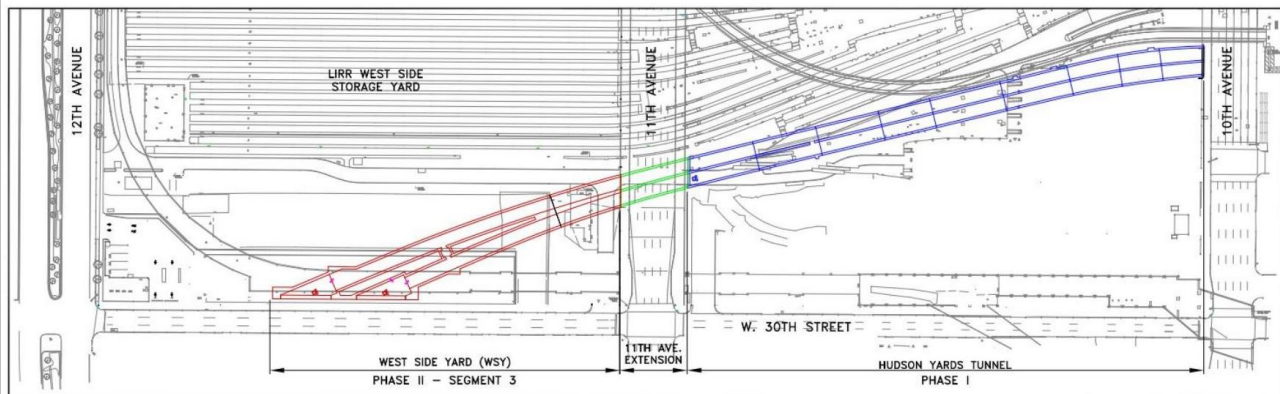


1,000 Year Flood Extent  
(0.1% annual chance)

0 0.1 0.2 Miles







Source: Personal Communication, Amtrak

## Project Description

The Amtrak Hudson Yards Concrete Casing project is part of an earlier phase of the proposed Amtrak Gateway Hudson Tunnel Project, which will create a new rail tunnel under the Hudson River into Penn Station in New York. The purpose of both projects is to increase resiliency of the Amtrak system through the North East Corridor. Prior to 2012, it was identified that the pending overbuild development of Long Island Railroad (LIRR) railyards between 30th and 33rd Streets and 10th and 12th Avenues in New York City would preclude future underground tunnel access to New York Penn Station. This project provides a “Right of Way” preservation in the form of reinforced concrete casings for future fit-out as serviceable tunnels via the Amtrak Hudson Tunnel Gateway Project.

## Solution

The work performed under this project specifically included concrete casing extension designed to preserve the right-of-way in the Hudson Yards to improve both the intercity and commuter rail system safety and reliability. These tunnel casings provide access for the planned Hudson Tunnels to connect to New York Penn Station and, as required, support identified existing and planned structures (e.g., new support of isolated portions of overbuild towers, re-support of the 11th Avenue viaduct, re-support of the High Line Park). To expedite construction and accommodate the rapidly progressing development, the project was split into three sections: Section 1 (approximately 825 feet) is between the west face of 10th Avenue and the east face of 11th Avenue under the East Rail Yard. Section 2 (approximately 100 feet) passes under 11th Avenue. Section 3 proceeds diagonally from the west face of 11th Avenue to the north face of 30th Street under the West Rail Yard.

The following permits were obtained for Sections 1 and 2 and will be obtained for Section 3: New York City Department of Environmental Protection Tunnel Permit, Notice of Intent NOI) to Perform Construction Under New York State Department of Environmental Conservation State Pollutant Discharge Elimination System (SPDES) Permit held by LIRR, Storm Water Pollution Prevention Plan (SWPPP) aka Sedimentation and Erosion Control Plan. The new right-of-way also allows for the possibility of future expansion of the commuter rail system between New Jersey and New York.





## Project Facts

*Managing Agency:* Amtrak

*Primary Federal Funder:* U.S. Federal Railroad Administration

*Authorization Agency and Status:* U.S. Federal Railroad Administration

*Project Status:* Construction

*Construction Agency and Status:* Sections 1 and 2 (complete) were constructed via a Design-Build entity consisting of an Engineering Partnership (then Parsons-Brinckerhoff, AECOM and STV) combined with Tutor Perini Corporation. Section 3 is planned to be competitively bid for Construction within Fiscal Year 2018.

*Project Elevation (ft NAVD88):* Preliminary FEMA 1% annual chance base flood elevation at the site is AE11-12

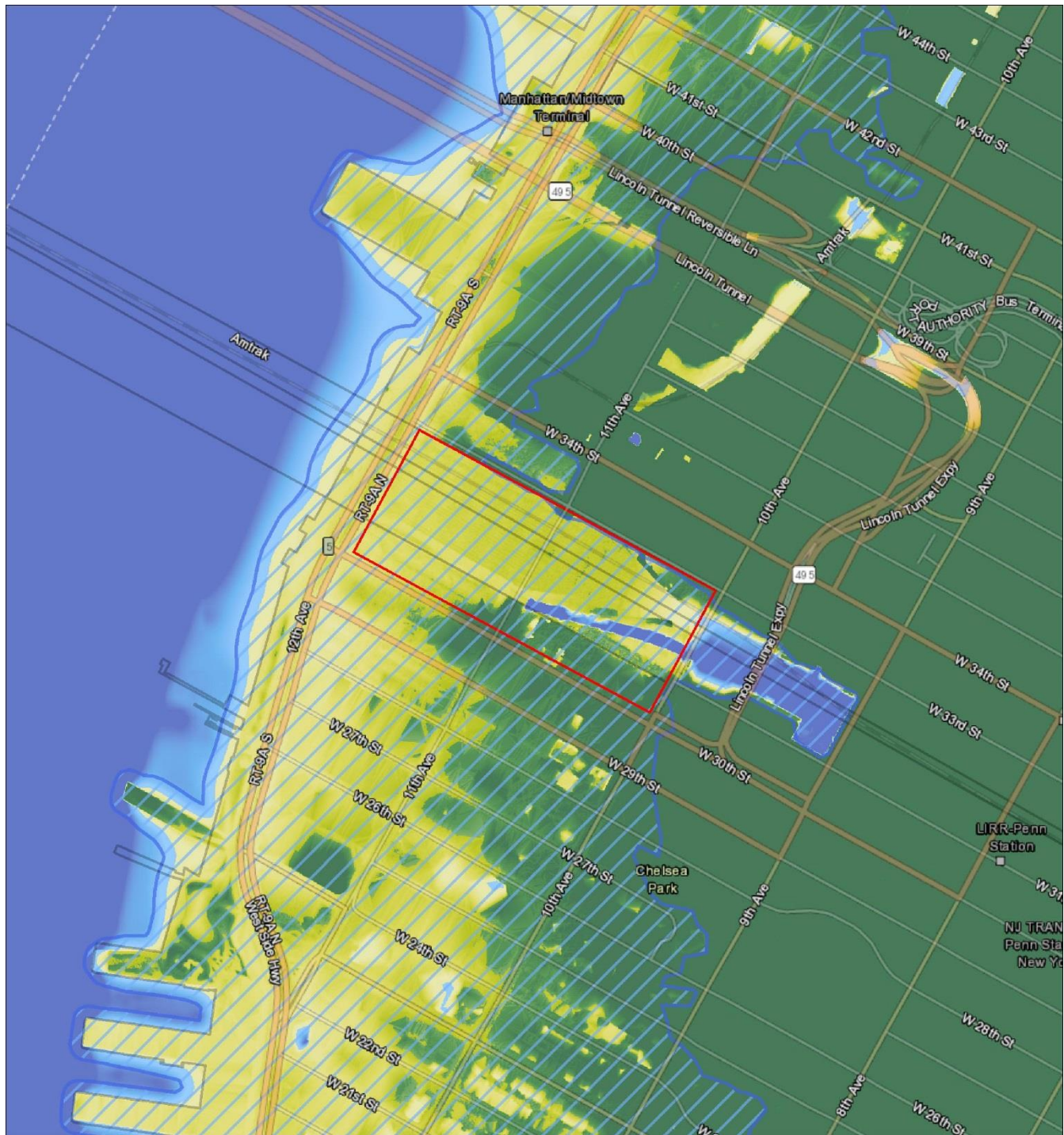
## Areas of Reduced Risk

- **Hudson Yards, Manhattan (also referred to John D. Caemmerer West Side Yard)**
- **Amtrak's Northeast Corridor**

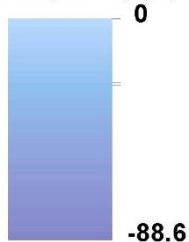
## References

1. P. Messick (personal communication, November 22, 2017). Project Information Request for USACE New York New Jersey Harbor and Tributaries Study
2. National Railroad Passenger Corporation (Amtrak) and Federal Railroad Administration (FRA). 2014. Supplemental Environmental Assessment for Construction of a Concrete Casing Extension in the Hudson Yards, New York, New York. Accessed June 2018. Available at <https://www.fra.dot.gov/Elib/Document/13993>

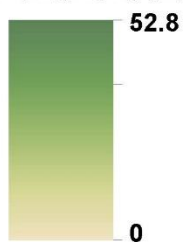




Bathymetry (ft)



Topography (ft)

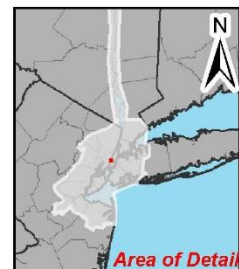


Amtrak Hudson Yards  
Concrete Casing



1,000 Year Flood Extent  
(0.1% annual chance)

0 0.1 0.2  
Miles







Source: MTA New York City Transit / Leonard Wiggins



Source: MTA New York City Transit / Leonard Wiggins

## Project Description

The 148th Street Rail Yard (Lenox Yard), located on the banks of the Harlem River, is at risk of flooding during storms. To ensure long-term resiliency of the rail yard, several updates and floodproofing measures have been designed. The planned work includes installation of floodproof sea walls, improvements to drainage systems, increased pumping capacity, and hardening measures.

## Solution

This project aims to prevent significant damage to key equipment and minimize disruption of service during and after extreme weather events. Specific improvements include:

- Construction of a reinforced concrete flood wall around the yard perimeter
- Extension of existing sheet pile wall along Harlem River
- Extension of land side perimeter wall
- Track replacement
- Construction of a stop log flood gate
- New drainage structures and track at the portal
- Updates to signal equipment, installation of new duct banks, power cables, and third rail hand switches

A U.S. Army Corps of Engineers (USACE)/New York State Department of Environmental Conservation (NYSDEC) joint permit was obtained to perform work in the East River watershed. Licenses to enter and use neighboring Esplanade Garden Housing Complex grounds is being acquired. Metropolitan Transit Authority (MTA) New York City Transit will have future project modification authority and operations and maintenance responsibility.

## Project Facts

*Managing Agency:* Metropolitan Transportation Authority (MTA)

*Primary Federal Funder:* U.S. Department of Transportation, Federal Transit Administration (FTA); grant funding was awarded in 2015

*Project Status:* Construction started on April 2018 and is anticipated to end in September 2021.

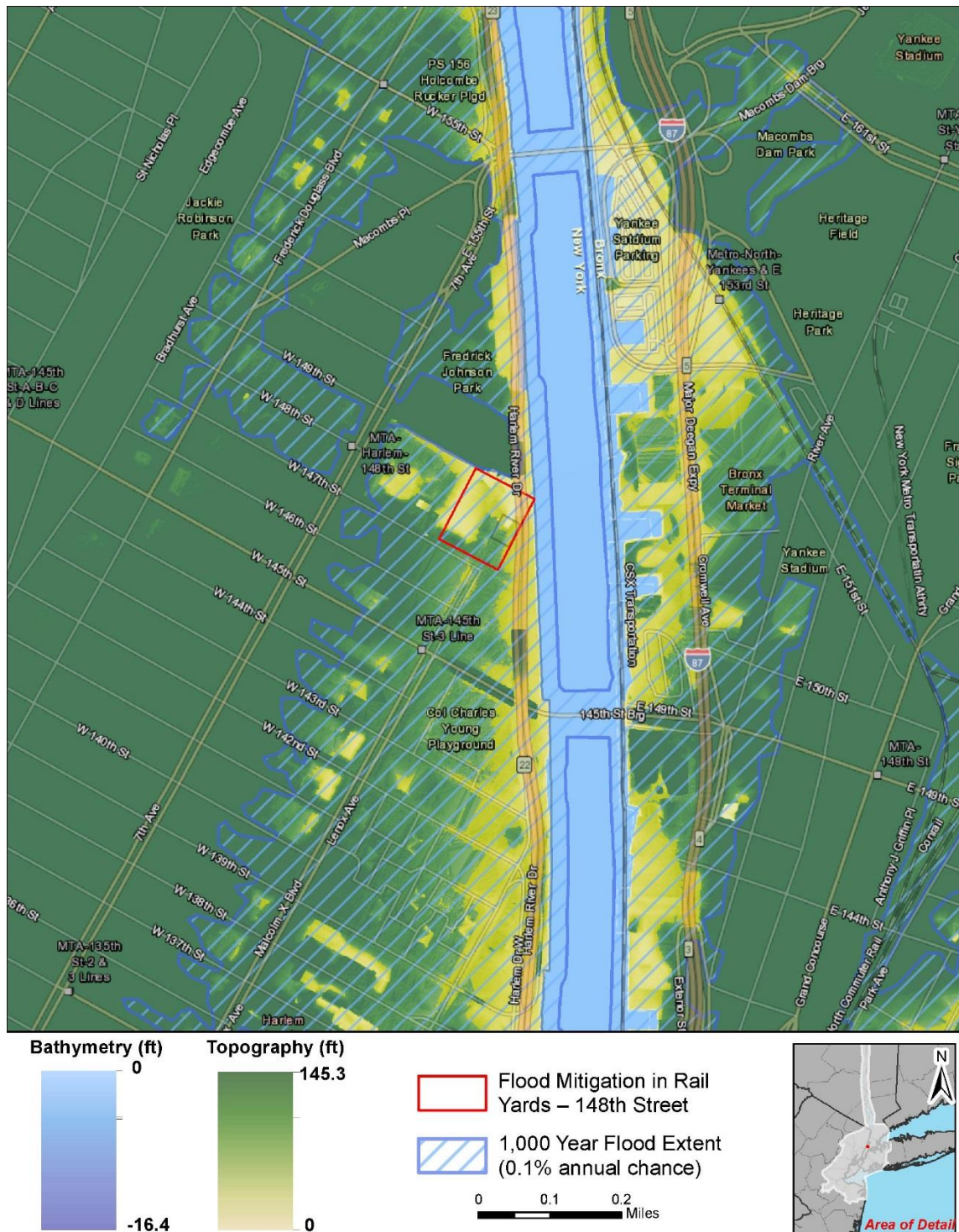
*Project Elevation (ft NAVD88):* The design flood elevation is 14.6 ft NAVD88 which corresponds to the 0.2% annual chance flood elevation + 2 feet

## Areas of Reduced Risk

- 148th Street Rail Yard, Manhattan, NY







## References

1. Dutta, P. (February 27, 2018). Personal communication.
2. Morgan, R. (June 15, 2018). Personal communication.
3. Metropolitan Transportation Authority (MTA) / Leonard Wiggins. 2012. *12. Lenox Terminal @ 148th St. in Flood Prep*. Accessed March 13, 2018. Available at <https://www.flickr.com/photos/mtaphotos/8135056730/>.
4. MTA / Leonard Wiggins. 2011. *04*. Accessed March 13, 2018. Available at <https://www.flickr.com/photos/mtaphotos/6090523619/>.
5. MTA. Capital Program Dashboard. Accessed June 1, 2018. Available at: <http://web.mta.info/capitaldashboard/CPDHome.html?AGENCY=a&PLN=Z>





## Project Description

In accordance with the Disaster Relief Appropriation Action of 2013 (Public Law 113-2), enacted by Congress in response to Hurricane Sandy in October 2012, the U.S. Army Corps of Engineers, New York District (USACE), completed a study, in partnership with the New Jersey Department of Environmental Protection (NJDEP), to analyze potential coastal storm risk management measures for Leonardo (a community located in Middletown Township), New Jersey.

Coastal storms have historically impacted the Raritan and Sandy Hook Bayshore areas, greatly altering the shoreline composition over time and causing extensive flooding and erosion to the area. Prior to Hurricane Sandy, 19 structures were identified for nonstructural treatment. Hurricane Sandy substantially damaged 12 out of the 19 structures. In an assessment of the post-Hurricane Sandy landscape, it was found that despite changes to the floodplain, stage frequency curves, and economics analyses, the fundamental conditions underlying the plan formulation still pointed to a small nonstructural solution. The remaining 7 structures were included in the post-Hurricane Sandy assessment, resulting in a recommendation of 22 structures for nonstructural treatment (elevation) to a height between +15 ft NAVD88 to +19 ft NAVD88. The project will be implemented with the Continuing Authorities Program, authorized by Section 103 of the River and Harbor Act of 1962 (CAP 103).

## Solution

The base flood elevations for affected structures range from +11 ft NAVD88 to +14 ft NAVD88. Each structure will be elevated between 2ft and 6 ft above the base flood elevation to meet the latest building standards for construction in a floodplain. To achieve this height, structures will be elevated anywhere between 2 ft to 11 ft from their existing elevations.

- Project Cost (estimated): \$5,545,000
- Benefit Cost Ratio (BCR): 1.1





## Project Facts

*Managing Agency:* USACE

*Primary Federal Funder:* USACE

*Authorization Agency and Status:* USACE – 1962 (CAP 103)

*Project Status:* Design & Implementation Phase

*Construction Agency and Status:* USACE – 2019

*Project Elevation (ft NAVD88):* N/A (non-structural solution)

## Areas of Reduced Risk

- Specific properties located in the Community of Leonardo (Middletown Township), NJ



## References

- U.S. Army Corps of Engineers. (September 2016). Leonardo, Raritan Bay and Sandy Hook Bay Coastal Storm Risk Management Feasibility Study – Final Detailed Project Report. Accessed December 2017.







## Project Description

In accordance with the Disaster Relief Appropriation Action of 2013 (Public Law 113-2), enacted by Congress in response to Hurricane Sandy in October 2012, the U.S. Army Corps of Engineers, New York District (USACE), completed a study, in partnership with the New Jersey Department of Environmental Protection (NJDEP), to reevaluate the authorized plan for The Joseph G. Minish Waterfront Park and Historic Area Coastal Streambank Stabilization Project, Newark, New Jersey.

Prior to Hurricane Sandy, Phase I of the Minish project was partially constructed. According to a letter from Mayor Luis Quintana (Newark, NJ) to COL Paul E. Owen (Commander, USACE District) dated 4 December 2013: *“During Superstorm Sandy, the Passaic River breached its banks and Newark’s residents endured flooding, exposure to pollutants, loss of power, jobs, transportation, and school days.”*

## Solution

A preliminary plan was developed in 1996 and included construction of 6,000 feet of bulkhead and 3,200 linear feet of stream bank stabilization; these measurements represent rounded, preliminary estimates and have been revised based on updated design. This phase (Phase I) has been partially constructed. Remaining construction includes 2,858 linear feet of bulkhead, 2,658 linear feet of stream bank stabilization and 1.68 acres of wetland mitigation, and the installation of railings and access ladders along the bulkhead including those sections previously constructed. Phases II and III, not funded for implementation, include a waterfront walkway and park and recreation facilities to provide recreation, social and economic development benefits.

- Project Cost (estimated): \$56,692,400 (completion of Phase I)
- Benefit Cost Ratio (BCR): 1.1 to 1.3 (linked to the Passaic River Main Stem Project)



## Project Facts

*Managing Agency:* USACE

*Primary Federal Funder:* USACE

*Authorization Agency and Status:* USACE – 1990 (WRDA), 2016 (Approval of P.L. 113-2 HSLRR)

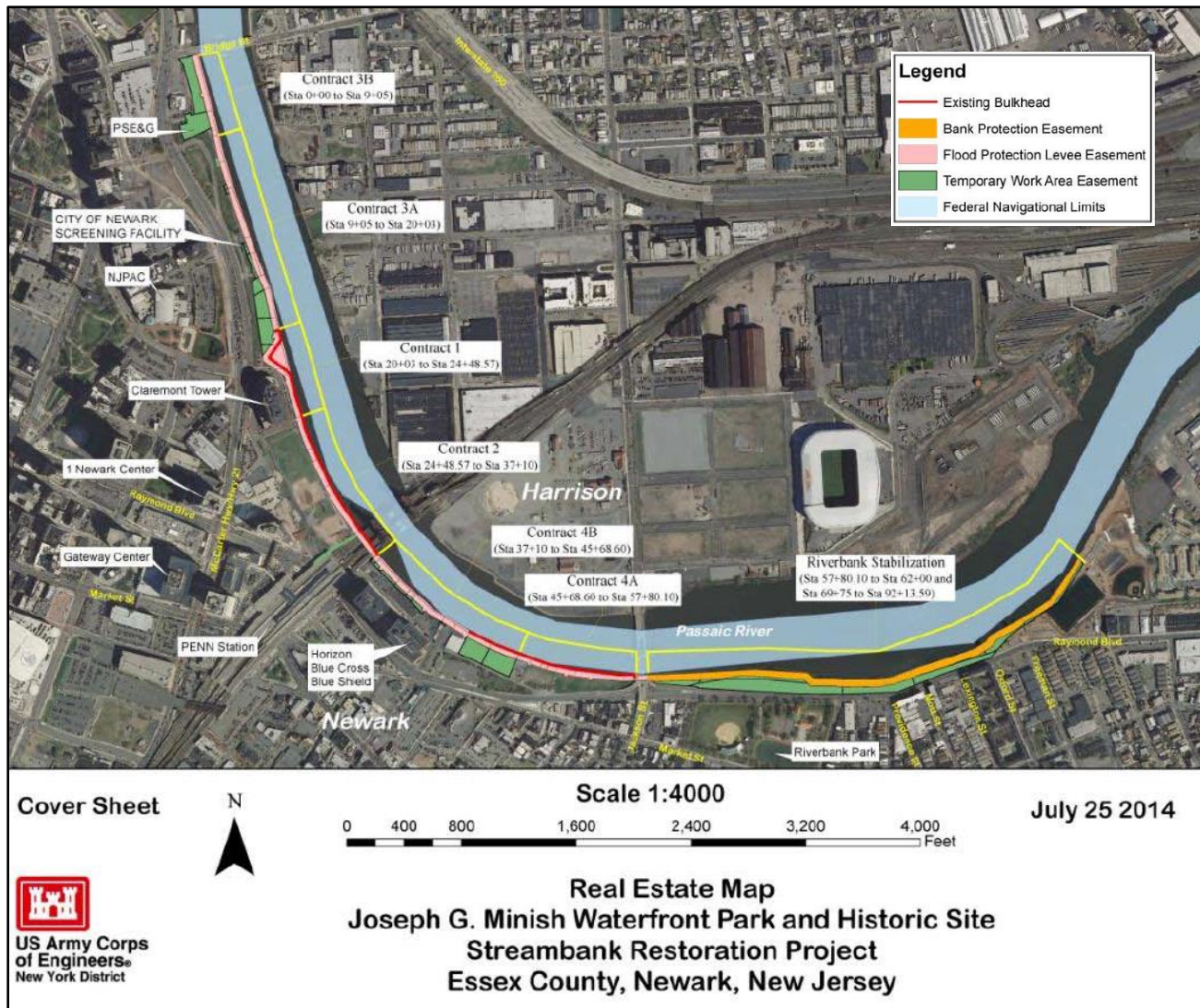
*Project Status:* Construction Phase

*Construction Agency and Status:* USACE – 2019 (restart Phase I)

*Project Elevation (ft NAVD88):* N/A (streambank stabilization at grade)

## Areas of Reduced Risk

- The Passaic River streambank located between Bridge Street & Brill Street in Newark, NJ



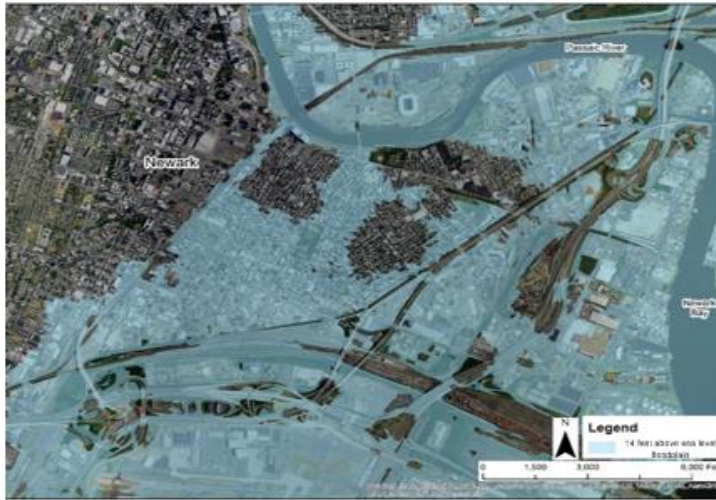
## References

1. U.S. Army Corps of Engineers. (March 2016). Joseph G. Minish Passaic River Waterfront Park and Historic Area – Phase I – Final HSLRR and EA Final Report, approved October 2016. Accessed December 2017.
2. U.S. Army Corps of Engineers. (May 1996, revised May 1997 and December 1997). Joseph G. Minish Passaic River Waterfront Park and Historic Area – Design Memorandum, approved by the Chief of Engineers on October 01, 1997. Accessed December 2017.





NEWARK SURGE FLOODING WITHOUT PROJECT



NEWARK SURGE FLOODING WITH PROJECT



## Project Description

In accordance with the Disaster Relief Appropriation Action of 2013 (Public Law 113-2), enacted by Congress in response to Hurricane Sandy in October 2012, the U.S. Army Corps of Engineers, New York District (USACE), is conducting a study in partnership with the New Jersey Department of Environmental Protection (NJDEP) to reevaluate potential coastal storm risk management measures for the tidally-influenced and surge-prone areas in the lower Passaic and Hackensack Rivers, and Newark Bay, New Jersey.

The waterfront areas of Newark, Kearny, and Harrison were severely impacted by Hurricane Sandy (October 28-30, 2012). The storm surge inundated an extensive area of highly developed industrial, commercial, and residential neighborhoods. In Newark, 266 homes and 10,522 businesses were damaged; Harrison had 100 homes and 536 businesses damaged; and Kearny had 96 homes and 1,484 businesses damaged ([www.njspotlight.com](http://www.njspotlight.com)). The highly utilized urban transit systems of the PATH, NJ Transit, and Amtrak were also severely impacted and operate through this area and the transportation infrastructure was extensively damaged from the storm surge. There were two documented fatalities in the study area due to the storm surge.

## Solution

A reevaluation of the authorized project has resulted in a tentative recommendation for the “Newark Flanking Plan”. The proposed Plan consists of seven (7) flood wall segments. The floodwalls will reduce the risk of damages from coastal storm surge to an approximate water level of 12 to 14 feet above sea level. Project features include:

- 2,730 linear feet of floodwall (in total)
- 5 road closure gates
- 5 railroad closure gates (9 tracks)
- 1 tide gate
- Interior drainage improvements for the City of Newark
- Project Cost (estimated): \$46,000,000
- Benefit Cost Ratio (BCR): 4.7



## Project Facts

*Managing Agency:* USACE

*Primary Federal Funder:* USACE

*Authorization Agency and Status:* USACE - 2019

*Project Status:* Study (Reevaluation) Phase

*Construction Agency and Status:* USACE - 2020

*Project Elevation (ft NAVD88):* 12' to 14'

## Areas of Reduced Risk

- Residential area in the Ironbound Section of Newark NJ



- |   |   |
|---|---|
| <p><b>Element 1</b></p> <ul style="list-style-type: none"> <li>• 290 feet long</li> <li>• Max. height above ground: 4 feet</li> <li>• Includes two roadway closures</li> <li>• Wall segments tie into railroad embankments</li> </ul> | <p><b>Element 2</b></p> <ul style="list-style-type: none"> <li>• 705 feet long</li> <li>• Max. height above ground: 8.2 feet</li> <li>• Includes five railroad closure gates</li> <li>• Crosses nine sets of railroad tracks</li> </ul> |
|---|---|



- |   |  |  |
|---|--|--|
| <p><b>Element 3</b></p> <ul style="list-style-type: none"> <li>• 139 feet long</li> <li>• Max. height above ground: 9.4 feet</li> <li>• includes an outfall with backflow prevention</li> </ul> | <p><b>Element 4</b></p> <ul style="list-style-type: none"> <li>• 180 feet long</li> <li>• Max. height above ground: 4.8 feet</li> <li>• includes a roadway closure gate</li> </ul> | <p><b>Element 5</b></p> <ul style="list-style-type: none"> <li>• 226 feet long</li> <li>• Max. Height above ground: 3.2 feet</li> <li>• includes a roadway closure gate</li> </ul> |
|---|--|--|



- |   |   |
|---|---|
| <p><b>Element 6</b></p> <ul style="list-style-type: none"> <li>• 204 feet long</li> <li>• Max. height above ground: 3.1 feet</li> <li>• One roadway crossing</li> </ul> | <p><b>Element 8</b></p> <ul style="list-style-type: none"> <li>• 297 feet long</li> <li>• Max. height above ground: 3.4 feet</li> <li>• Could be integrated into the Riverfront Park's natural slope</li> </ul> |
|---|---|



**US Army Corps  
of Engineers®**  
New York District

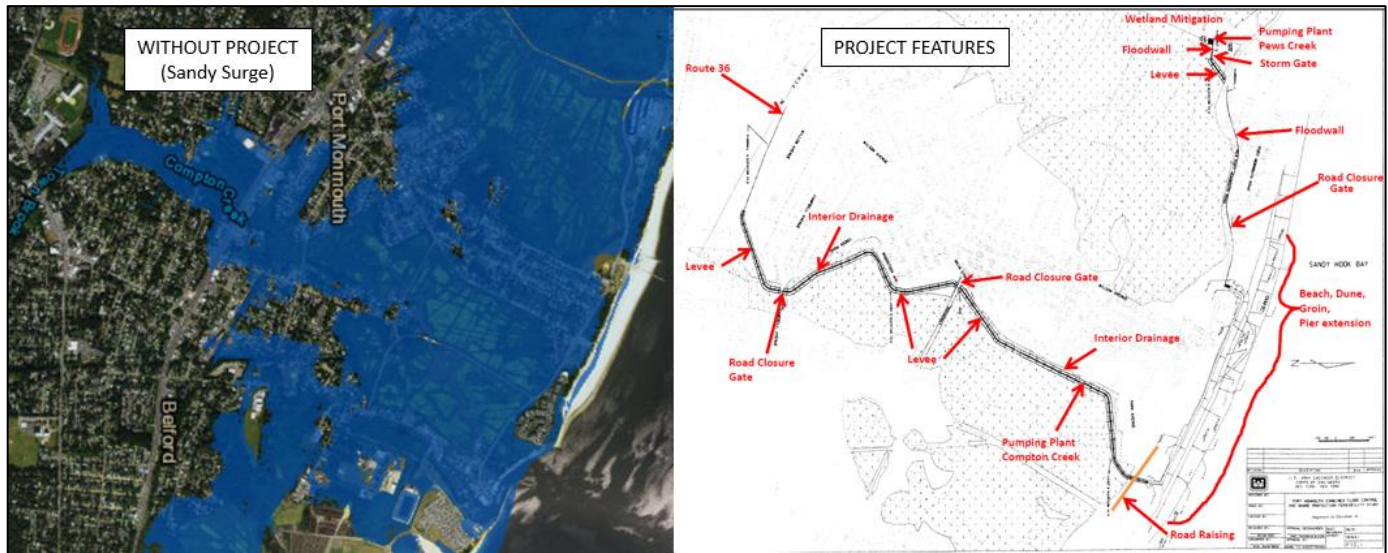


## References

- U.S. Army Corps of Engineers. (September 2017). Draft Integrated General Reevaluation Report and Environmental Assessment. Available at <http://www.nan.usace.army.mil>. Accessed December 2017.







## Project Description

In accordance with the Disaster Relief Appropriation Action of 2013 (Public Law 113-2), enacted by Congress in response to Hurricane Sandy in October 2012, the U.S. Army Corps of Engineers, New York District (USACE), completed a study, in partnership with the New Jersey Department of Environmental Protection (NJDEP), to reevaluate potential coastal storm risk management measures for the Port Monmouth (a community located in Middletown Township), New Jersey.

Coastal storms have historically impacted the Raritan and Sandy Hook Bayshore areas, greatly altering the shoreline composition over time and causing extensive flooding and erosion to the area. Hurricane Sandy caused extensive damage to Port Monmouth, NJ. Approximately 700 of 1000 structures experienced flood damage, including 3 that were destroyed.

## Solution

The authorized project consists of approximately 7,070 feet of levee at an elevation of + 14.0 feet North Atlantic Vertical datum (NAVD 88), 3,585 feet of floodwall at an elevation of +14 feet NAVD 88, 2,640 feet of dune at elevation +16 feet NAVD 88 with dune grass, fencing, wooden dune walkovers, a terminal groin, a storm gate across Pews Creek, three local road closure gates, and the raising of Port Monmouth Road; as generally described in the Raritan Bay and Sandy Hook Bay, Port Monmouth Feasibility Report, dated June 2000, and approved by the Chief of Engineers on December 4, 2000, and as modified by the Raritan Bay and Sandy Hook Bay, Port Monmouth, New Jersey, Hurricane Sandy Limited Reevaluation Report (HSLRR), dated June 2013 and approved December 2013.

- Project Cost (estimated): \$104,692,000
- Benefit Cost Ratio (BCR): 1.2



## Project Facts

*Managing Agency:* USACE

*Primary Federal Funding Agency:* USACE

*Non-Federal Cost-Share Partner:* NJDEP

*Authorization Agency and Status:* USACE – 2000, 2013

*Project Status:* Construction Phase

*Construction Agency and Status:* USACE – 2014 (ongoing)

*Project Elevation (ft NAVD88):* 14' levees & floodwalls;  
16' dune

## Areas of Reduced Risk

- Community of Port Monmouth (Middletown Township), NJ

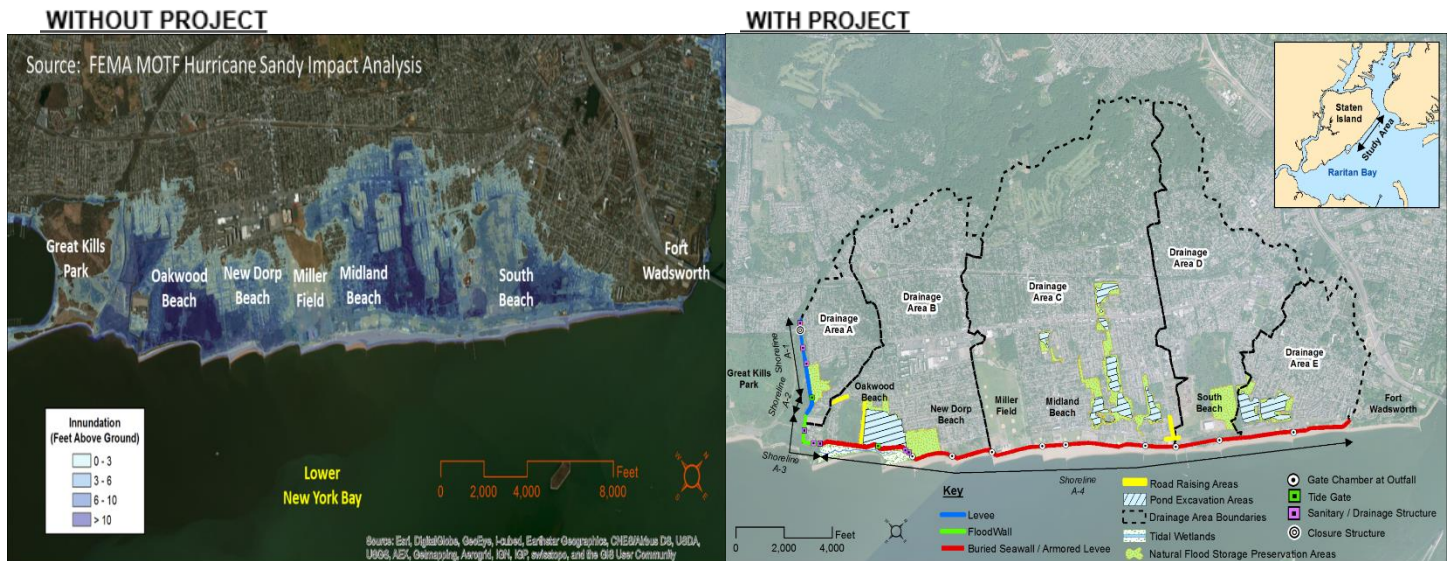


## References

- U.S. Army Corps of Engineers. (June 2000). Raritan Bay and Sandy Hook Bay, Port Monmouth Feasibility Report, approved by the Chief of Engineers on December 4, 2000. Accessed December 2017.
- U.S. Army Corps of Engineers. (June 2013). Raritan Bay and Sandy Hook Bay, Union Beach, New Jersey, Hurricane Sandy Limited Reevaluation Report (HSLRR), approved December 2013. Accessed December 2017.







## Project Description

In accordance with the Disaster Relief Appropriation Action of 2013 (Public Law 113-2), enacted by Congress in response to Hurricane Sandy in October 2012, the U.S. Army Corps of Engineers, New York District (USACE), completed a study, in partnership with the New York Department of Environmental Conservation (NYDEC) and the City of New York, to evaluate potential coastal storm risk management measures for the South Shore of Staten Island, Richmond County, New York.

Coastal storms have historically impacted the South Shore of Staten Island, with the most critical and vulnerable area from Fort Wadsworth to Oakwood Beach experiencing flood damages to life and property. Hurricane Sandy caused extensive damage to the South Shore of Staten Island. The damage in the study area, and the loss of life during Hurricane Sandy was particularly devastating because of the bowl shaped nature of the area, trapping the floodwaters from the high waves that overtopped the existing coastal topography. Twenty-four people died in Staten Island which accounts for 45% of total deaths due to Hurricane Sandy. Thousands of homes were flooded and in some areas, floodwaters reached up to 8-10 feet.

## Solution

The authorized project generally consists of three typical structures, with a total length of 5.3 miles, and a still water design level of +14.5ft. NAVD88. Consisting of approximately 4.5 miles, a sand-covered buried seawall that supports native vegetation with a crest elevations of +19.4 ft NAVD88, includes an elevated boardwalk or promenade. The seawall runs the entire length of the project from Fort Wadsworth to Oakwood Beach. At Oakwood Beach, the seawall transitions into a vertical floodwall at the wastewater treatment plant with a top of wall elevation of +19.4 ft NAVD88. A fronting tidal wetland will attenuate the wave forces and preserve the functionality of the tidal creek through a tide gate to the freshwater wetlands that serve as part of the project's interior drainage. With crest elevation of +16.9 ft NAVD88 an earthen levee terminates into high ground near Hylan Boulevard. A road closure structure along Hylan Boulevard will be deployed only during rare coastal storm events to prevent the flanking of tidal surge waters to the project area.

The Interior Drainage Plans include the acquisition and preservation of open space, pond excavation, construction of tide gates and gate chambers along the project alignment, road raisings, and other minor interior drainage measures.



These features are generally described in the South Shore of Staten Island, NY, Fort Wadsworth to Oakwood Beach Coastal Storm Risk Management, Interim Feasibility Report, dated October 2016 and approved by the Director of Civil Works, 27 Oct 2016.

- Project Cost (estimated): \$615,231,000
- Benefit Cost Ratio (BCR): 1.3

## Project Facts

*Managing Agency:* USACE

*Primary Federal Funding Agency:* USACE

*Non-Federal Cost-Share Partner:* NYSDEC/NYC

*Authorization Agency and Status:* USACE – 2016

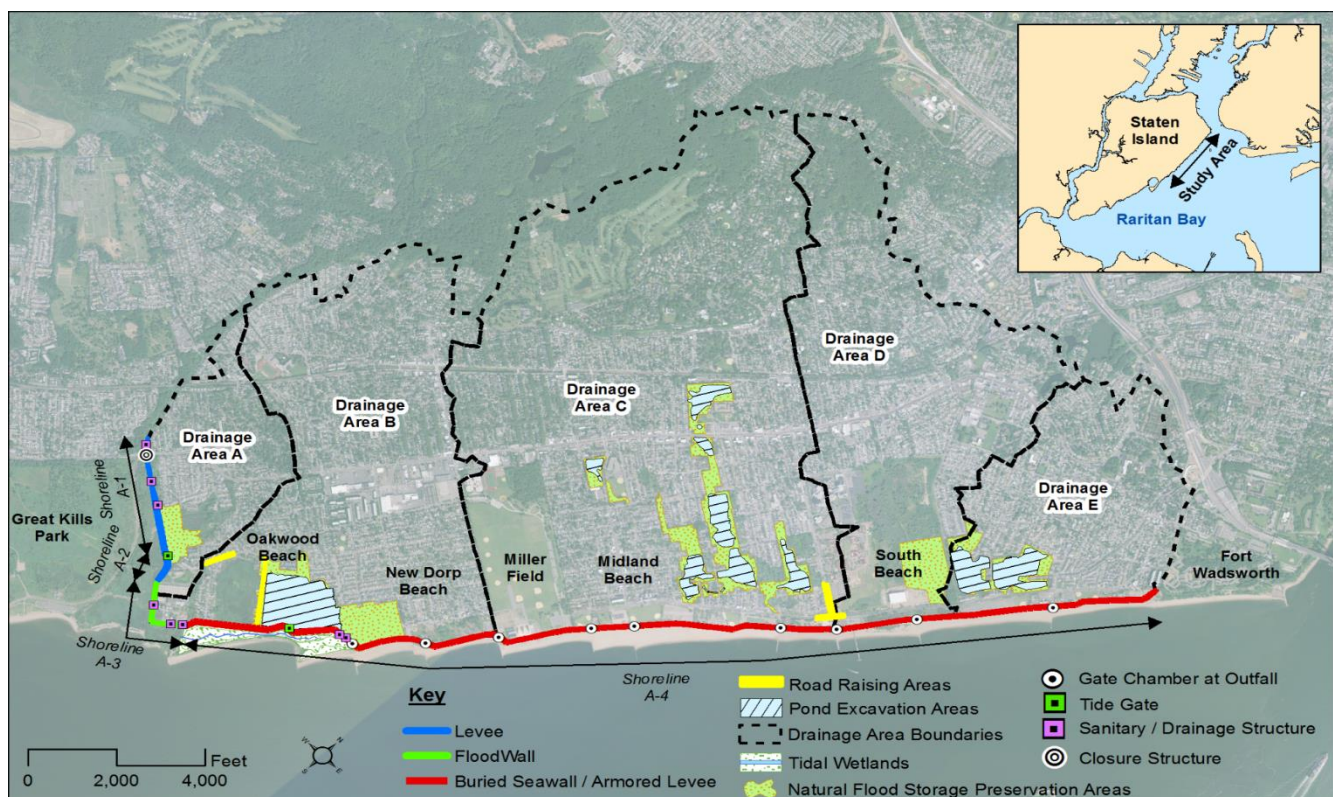
*Project Status:* Construction Phase

*Construction Agency and Status:* USACE - 2018

*Project Elevation (ft NAVD88):* 19.4 ft seawall

## Areas of Reduced Risk

- South Shore of Staten Island, Fort Wadsworth to Oakwood Beach

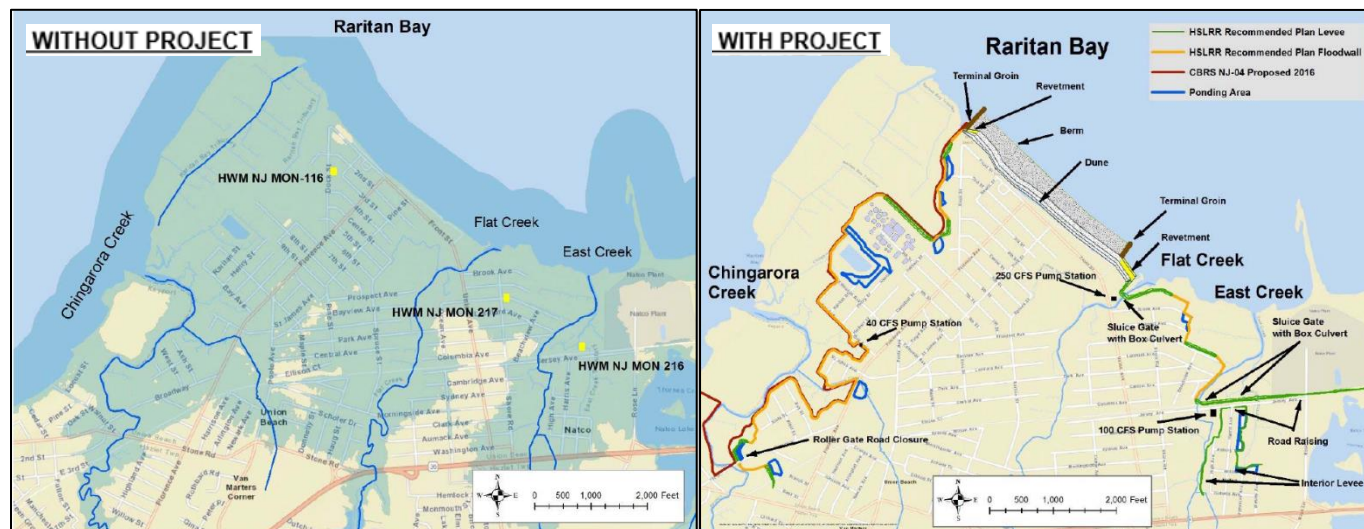


## References

1. U.S. Army Corps of Engineers. (October 2016). South Shore of Staten Island, NY, Fort Wadsworth to Union Beach, Coastal Storm Risk Management Interim Feasibility Report, approved by the Director of Civil Works, 27 Oct 2016. Accessed December 2017.







## Project Description

In accordance with the Disaster Relief Appropriation Action of 2013 (Public Law 113-2), enacted by Congress in response to Hurricane Sandy in October 2012, the U.S. Army Corps of Engineers, New York District (USACE), completed a study, in partnership with the New Jersey Department of Environmental Protection (NJDEP), to reevaluate potential coastal storm risk management measures for the Borough of Union Beach, New Jersey.

Coastal storms have historically impacted the Raritan and Sandy Hook Bayshore areas, greatly altering the shoreline composition over time and causing extensive flooding and erosion to the area. Hurricane Sandy caused extensive damage to Union Beach. Approximately 90 percent of the Borough's land was flooded, ranging from 2 to 10 feet in depth, over 2,000 structures were inundated, including 60 that were destroyed, approximately 24,500 tons of storm damage debris littered the Borough and the Bayshore Regional Sewage Authority wastewater treatment plant (serves 100,000 people in eight townships) was inundated with three to five feet of salt water. Every process in the plant was damaged, and full operation was delayed for several months.

## Solution

The authorized project consists of approximately 6,800 feet of levee at an elevation of + 14.0 feet North Atlantic Vertical datum (NAVD 88), 3,400 feet of interior levee at an elevation of +7 feet NAVD 88, 12,900 feet of floodwall at an elevation of +14 feet NAVD 88, 3,160 feet of dune at elevation +16 feet NAVD 88 with dune grass, fencing, wooden dune walkovers and walkway, and beach berm at elevation +8 feet NGVD 88 with terminal groins and revetments, a road closure gate, 2 sluice gates, 3 pump stations, and 22 acres of wetland mitigation as generally described in the Raritan Bay and Sandy Hook Bay, Union Beach Feasibility Report, dated September 2003, and approved by the Chief of Engineers on January 4, 2006, and as modified by the Raritan Bay and Sandy Hook Bay, Union Beach, New Jersey, Hurricane Sandy Limited Reevaluation Report (HSLRR), dated June 2017.

- Project Cost (estimated): \$289,245,000
- Benefit Cost Ratio (BCR): 1.2



## Project Facts

*Managing Agency:* USACE

*Primary Federal Funding Agency:* USACE

*Non-Federal Cost-Share Partner:* NJDEP

*Authorization Agency and Status:* USACE – 2007, 2017

*Project Status:* Construction Phase

*Construction Agency and Status:* USACE - 2018

*Project Elevation (ft NAVD88):* 14' levees & floodwalls;  
16' dune

## Areas of Reduced Risk

- Borough of Union Beach, NJ





## References

1. U.S. Army Corps of Engineers. (September 2003). Raritan Bay and Sandy Hook Bay, Union Beach Feasibility Report, approved by the Chief of Engineers on January 4, 2006. Accessed December 2017.
2. U.S. Army Corps of Engineers. (June 2017). Raritan Bay and Sandy Hook Bay, Union Beach, New Jersey, Hurricane Sandy Limited Reevaluation Report (HSLRR). Accessed December 2017.



Source:

Source:

## Project Description

The Middlesex County Utilities Authority (MCUA) owns and operated the Edison Pump Station (MCUAEPS), which is a regional raw sewage pumping facility that is located in Woodbridge, NJ. The facility serves 145,000 residents and pumps approximately 85-million gallons per day of average daily dry weather sanitary flow from Carteret, Perth Amboy, Edison, and Woodbridge. During Hurricane Sandy, the facility sustained \$5 million of capital damages, 9-days of complete loss of wastewater service, and an estimated 156-million-gallon spill of raw sewage into the Raritan River. President Barack Obama declared Hurricane Sandy a major disaster, making this facility available to receive a FEMA Public Assistance (PA) grant to recover from the damages.

## Solution

The Edison Pump Station received a FEMA PA grant for mitigation after Hurricane Sandy. The action taken was to restore and upgrade the facility; including building a poured concrete floodwall around the perimeter of the entire facility (1.2 acres), installing a new isolation vault and pumping system, constructing a new station control building, work on the five existing 500HP main pump motors, electrical work to transformers, extending the wet wells above the 500 year still-water elevation in order to protect against flooding from inside of the facility, and backup power in order to keep the facility dewatered during a precipitation event in Edison. The State of New Jersey provided MCUA financing of \$35M through NJ SAIL (Statewide Assistance Infrastructure Loan) Program using its EPA Clean Water State Revolving Fund for bridge financing, including for elements not eligible for FEMA PA. FEMA is considering an amendment regarding additional costs. Construction is underway.





## Project Facts

*Managing Agency:* NJ State

*Primary Federal Funder:* FEMA PA

*Project Status:* In Construction, will be completed in 2020

*Project Elevation (ft NAVD88):* 23 feet NAVD88

*Environmental Documentation:* Environmental Assessment

## Areas of Reduced Risk

- **Edison Pump Station**

## References

1. FEMA. 2015. Draft Environmental Assessment Middlesex County Utilities Authority Restoration, Upgrade, and Flood Hazard Mitigation of the Edison Pump Station, Edison Township, Middlesex County, New Jersey. Report number: FEMA-4086-DR-NJ
2. Personal communication Joe Cryan. July 6, 2018.





9th and Madison Streets in Hoboken at 10:45 a.m. on December 9, 2014. This flooding will be alleviated by the new H-5 Wet Weather Pump Station. Source: [http://www.nhudsonsa.com/Public/H-5\\_WWPS.html](http://www.nhudsonsa.com/Public/H-5_WWPS.html)



Ceremony to lower and secure the pumps for the H5 wet weather pump station. Source: <http://hoboken.nj.gov/2016/06/hoboken-nhsa-officials-lower-the-pumps-for-new-h-5-flood-pump-station/>

## Project Description

The City of Hoboken has been beset by wet weather and tidal flooding since the mid-19th century. It was only after the establishment of the North Hudson Sewerage Authority in 1988 that the issue of flood management and prevention was examined seriously and given priority. Wet weather flooding in Hoboken is a result of a combination of factors: severe rainfall in a concentrated period of time, high tides in the Hudson River, and low lying street levels. This combination prevents storm water from draining through the sewers and outfall pipes into the Hudson. With no way to exit to the river, storm water fills the sewer lines and backs on to the streets in the lowest lying areas of the City. Wet weather pump stations enable the storm water to be pumped against the tide, forcing the flow into the Hudson and preventing street flooding. The southwestern neighborhood (H1) was the worst hit, and fixed with the installation of the H1 pump station in 2011. The northwestern neighborhood (H5) is the second worst hit neighborhood, and was addressed by this project, the construction of the H5 Wet Weather Pump.

## Solution

The H5 Wet Weather Pump Station included the following elements: a below-grade 40 mgd pump station, a below-grade transition vault, a below-grade electrical vault, and emergency 725 kW generator. Additionally, the nearby streets were raised to be equivalent to the elevation of the manhole at the intersection of Madison and 9<sup>th</sup> street (since this location usually remains dry during heavy precipitation events). The existing combined sewer outfall (CSO) for the H5 service area discharges by gravity into the Hudson River at the foot of 11th Street, however during periods of heavy precipitation in the service area and/or high tides, flow is restricted causing upstream flooding. To alleviate flooding, the H5 Wet Weather Pump Station will pump flow to the Hudson River when conditions exist that prevent gravity flow. The pump station and transition vault are located within the 100-year flood plain and will operate irrespective of street flooding in, around, and on top of the H5 Wet Weather Pump Station. To meet both spatial and aesthetic limitations, all the necessary infrastructure for the pump station, transition vault, and electrical vault are located below grade with access from at-grade hatches. With the project in place, street flow during heavy precipitation events is





be reduced down to a height of only 10-12". Before the project, the street flow was much deeper.

## Project Facts

*Managing Agency:* NJDEP

*Primary Federal Funder:* US EPA

*Project Status:* Completed

*Project Elevation (ft NAVD88):* This does not apply to this project.

*Environmental Documentation:* None required for project.

*GIS Data:* None acquired during project.

## Areas of Reduced Risk

- **The northwestern neighborhood of Hoboken (H5)**

## References

1. North Hudson Sewerage Authority. 2018. H-5 Wet Weather Pump Station. Available at: [http://www.nhudsonsa.com/Public/H-5\\_WWPS.html](http://www.nhudsonsa.com/Public/H-5_WWPS.html). Accessed on: July 2, 2018.





Flooding and building damage in the South Street Seaport. Source: NYC Department of Small Business Services.



Projected extent of a 100-year storm surge event in 2100 in Lower Manhattan. Source: NYC, Community Board 1 Presentation

## Project Description

After Hurricane Sandy, it was apparent that New York City needed to prepare for both the next storm, and the effects of climate change. Lower Manhattan is a high-need area for this type of project. With projected sea level rise, more than half of all buildings in Lower Manhattan will be at risk from a 100-year storm surge in 2100. Finding a way to reduce flooding risks in this area is a top priority for the City Of New York. Threats to this area are threats for the entire city. For example, 9.2% of NYC's total GDP comes from Lower Manhattan. Additionally, nearly 70% of all subway lines travel through Lower Manhattan, a system that serves the entire city.

## Solution

In August 2014, Mayor de Blasio dedicated \$108 million towards protecting Lower Manhattan's community and infrastructure from coastal storms. The complete Lower Manhattan Coastal Resiliency project area stretches from Montgomery Street to the north end of Battery Park City, but will be implemented in separate sections; 1) the Two Bridges project will stretch from Montgomery Street to the Brooklyn Bridge, 2) the Financial District project will stretch from the Brooklyn Bridge to Battery Park City, and 3) the Battery Park City Authority will also be advancing resiliency projects, and have projects in advanced and conceptual design. The Two Bridges project will be developed first. Building on the money set aside by the Mayor, the City secured a \$176 million grant from the U.S. Department of Housing and Urban Development's (HUD) National Disaster Resilience Competition (NDRC) to enable the implementation of integrated flood protection in the Two Bridges project in January 2016. Another \$27 million in City capital has been dedicated to fund the Two Bridges project.

A range of structural and nonstructural measures are being considered. As part of this analysis the City has studied the full range of options for edge protections including, but not limited to; 1) edge adjusted for Sea Level Rise impacts 2) edge raised to address surge impacts 3) outboard protection. The measures being considered in the public realm include green streets, elevated streets, an elevated





pedestrian realm, and to increase tree canopy. The measures built in the subsurface include utility boxes, emergency pumping, raised utilities, stormwater tanks, and parallel systems. Measures to protect buildings include: Stormwater retention, local energy assurance, deployable barriers, elevated utilities, wet floodproofing, dry floodproofing, and stabilization/tie down. These measures have been combined into five alternatives (1, 2, 3A.1, 3A.2, and 3B). While this major project is being developed, the City is investigating the feasibility of Interim Flood Protection Measures (IFPM) for Lower Manhattan. The goal of this program is to reduce the low-level, high recurrence coastal flood risks while the City continues to advance longer-term coastal protection needs. This program has already been implemented in the Red Hook neighborhood in Brooklyn. An IFPM design for the South Street Seaport has been drafted.

## Project Facts

*Managing Agency:* New York City

*Primary Federal Funder:* U.S. Department of Housing and Urban Development (HUD). \$176 million in 2016.

*Project Status:* The Two Bridges project recently completed conceptual design phase. The Financial District project is currently part of a comprehensive planning process for the neighborhood.

*Project Elevation (ft NAVD88):* 16.5 ft NAVD88

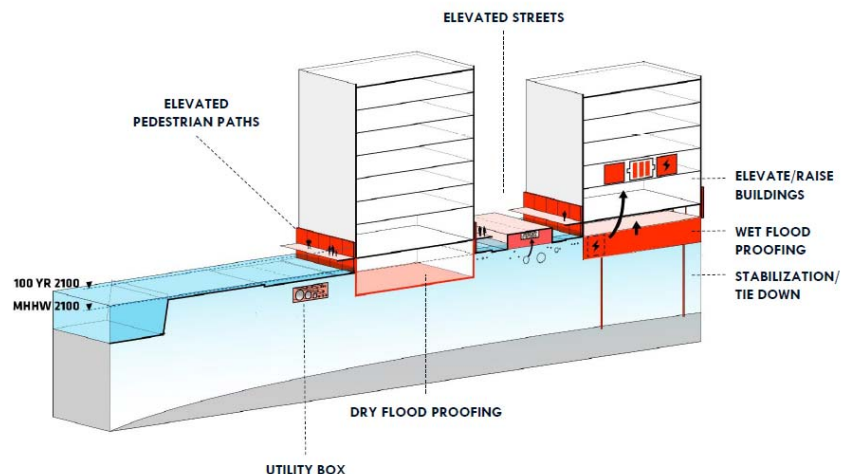
*Estimated Cost:* Two Bridges: \$203M (\$176M CDBG-NDR funds; \$27M City Capital Funds)  
Financial District/Below Brooklyn Bridge: \$100M of City Capital Funds/ The Battery: \$8M

*GIS Data:* For Two Bridges Project only.

## Areas of Reduced Risk

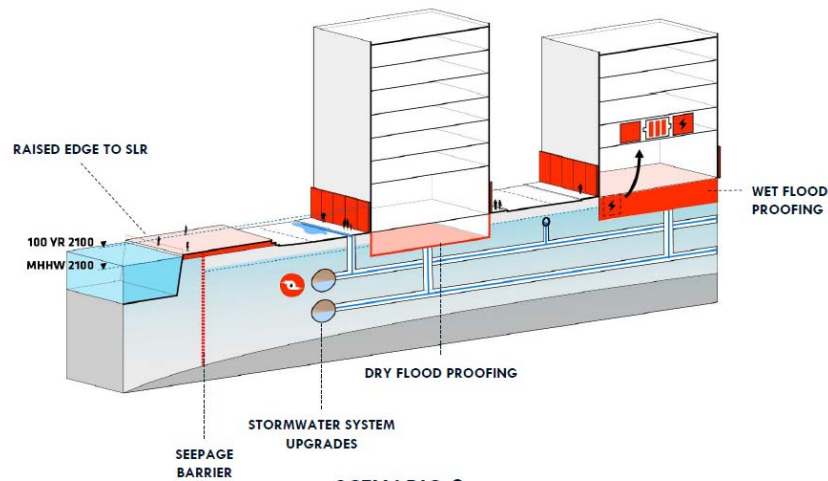
- **Lower Manhattan**
- **First the Two Bridges Neighborhood**
- **Second the Financial District**

### Scenario 1: Let All Water In

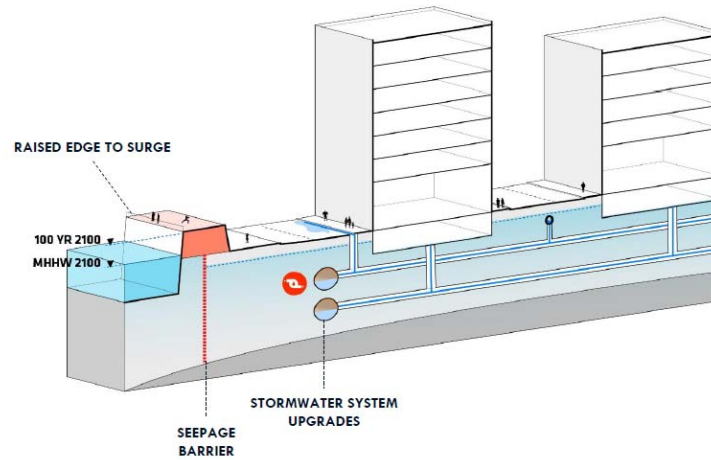


### Scenario 2: Let Lower Frequency Water In; Keep Higher Frequency Out

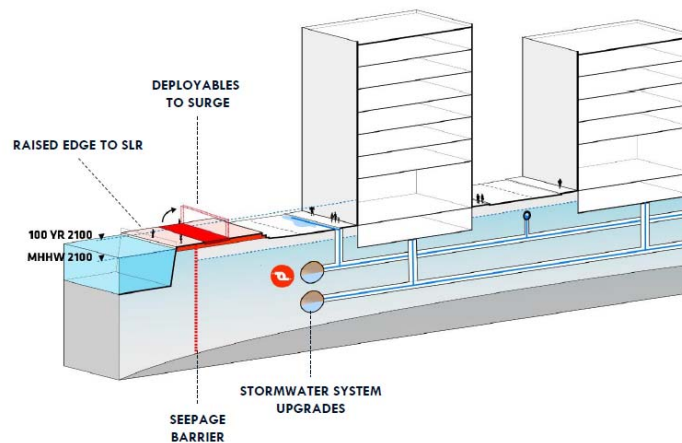




Scenario 3A.1: Let No Water In With Inboard, Passive Protection

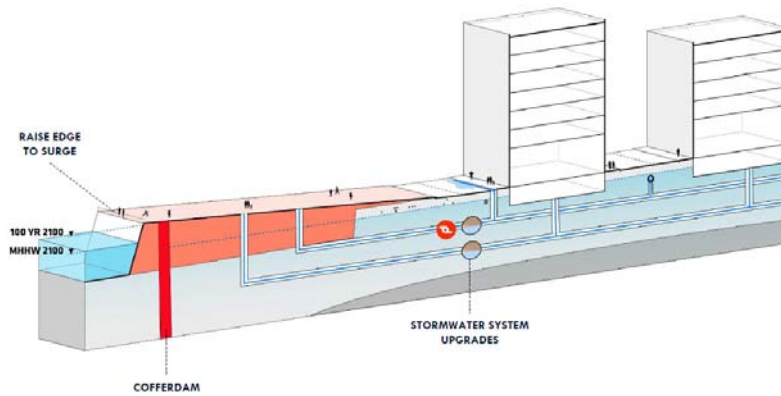


Scenario 3A.2: Let No Water in with Inboard, Deployable Protection



Scenario 3B: Let No Water In With Reclaimed Land Protection





### References

1. New York City. 2018. *Lower Manhattan Coastal Resiliency*. PowerPoint presented at Community Board 1 meeting on April 17, 2018. Available at: Accessed on June 26, 2018.  
<https://www1.nyc.gov/assets/lmcr/downloads/pdf/LMCRCB1Briefing4.17.184PM.PDF>.
2. New York City. 2018. *Lower Manhattan Coastal Resiliency Project*. Available at:  
<https://www1.nyc.gov/site/lmcr/index.page>. Accessed on June 26, 2018.







Overview of North Hudson Sewerage Authority Source:  
<http://www.nhudsonsa.com/CustomerService/contact.html>



Outside of North Hudson Sewerage Authority building. Source:  
<http://thehobokenjournal.blogspot.com/2010/07/north-hudson-sewerage-authority-fact.html>

## Project Description

Hoboken, NJ is located at a low elevation, making it be at a high risk of flooding. Sewage management is important during flooding to keep contaminants from spreading with the floodwaters. Floodproofing the North Hudson Sewerage Authority building was an important step towards this goal.

## Solution

The North Hudson Sewerage Authority received FEMA Public Assistance (PA) funding to build a stop gates in the garage of their administrative building in Hoboken, NJ, to install watertight doors, a sump pump and an exhaust system in the pipe tunnel, to install removable barriers at the exterior entrances, and to install a watertight conduit. As of September 2016, the building stop walls is complete, and the contract for the installation of the watertight doors is out to bid.

## Project Facts

*Managing Agency:* NJ State

*Primary Federal Funder:* USFEMA

*Project Status:* In Construction

*Project Elevation (ft NAVD88):* 100 year flood elevation. Ft NAVD88 unknown at this time.

*Environmental Documentation:* None needed for project

*GIS Data:* None acquired during project.

## Areas of Reduced Risk

- **North Hudson Sewerage Authority Facility**





Figure 1. Location of North Hudson Sewerage Authority. Source: Google Maps.

## References

1. Personal communication with Fred Pocci. July 19, 2018.





Source: Google Maps



## Project Description

NJ's EPA Clean Water State Revolving Fund project funded by NJDEP and NJEIT financing agreements. The project addresses the bulkhead constructed along the Raritan Bay frontage of the Old Bridge MUA property on Boulevard West in Cliffwood Beach, NJ. It will protect the 2 million gallon per day capacity Laurence Harbor Sewage Pump Station from storm damage and flood control along the Raritan Bay.

## Solution

To protect the utilities a flood wall with an average height of six feet was built.

## Project Facts

*Managing Agency:* Old Bridge Municipal Utilities Authority

*Primary Federal Funder:* NJEIT Trust

*Project Status:* Completed

## Areas of Reduced Risk

- **Protect utilities for the surrounding area**
- **Protect the Sewage Pump station from storm damage and flood control**

## References

1. Google Maps <https://www.google.com/maps/place/Old+Bridge+Municipal+Utilities+Authority/@40.4540105,-74.2334922,194m/data=!3m1!1e3!4m5!3m4!1s0x0:0x99828b8569660277!8m2!3d40.4533336!4d-74.2334845>





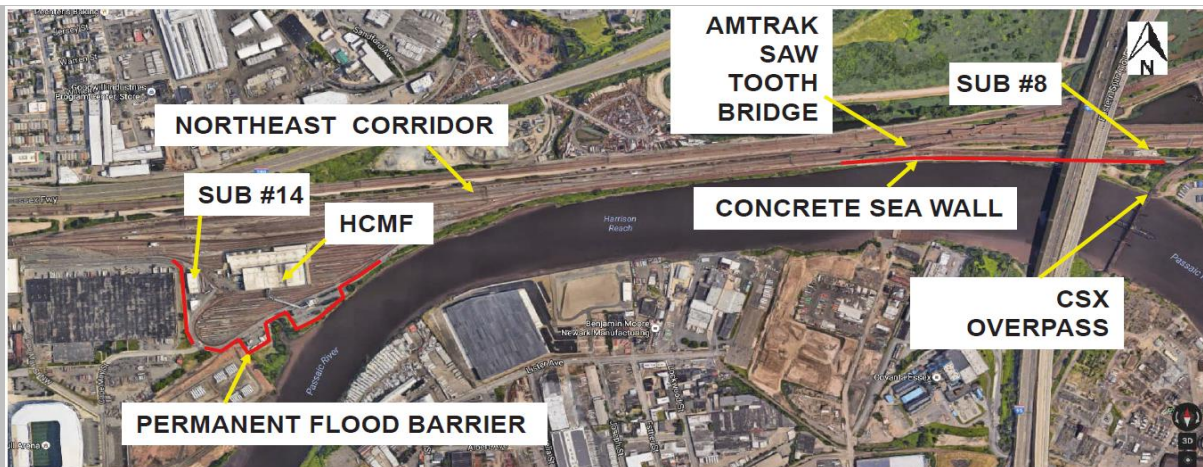


Image Provided by Port Authority of NY and NJ

## Project Description

The Harrison Car Maintenance Facility HCMF is located at the foot of Cape May Street in Harrison, along the banks of the Passaic River. The facility's shop serves as the primary location for PATH's rail car maintenance and repair activity. The adjoining rail car storage yard and adjacent rail tracks are also critical to PATH operations.

As a result of Hurricane Sandy and its associated storm surge, the HCMF, the rail car storage yard, and a section of PATH Tracks G and H located to the east of the HCMF were flooded, causing significant service outages and damage to the facility, rolling stock and rail yard. To address this issue on a temporary basis, in 2013, approximately 2,700 linear feet of a combined floodwall system, composed of bin block and cast-in-place concrete, was installed adjacent to the HCMF, and a protective 2,700-linear-foot sandbag wall was installed at the right of way adjacent to Tracks G and H, in order to provide temporary protection of these areas from future flood events. The existing temporary floodwall system at the HCMF averages approximately six feet in height, which does not meet the required flood protection standards under revised Federal Emergency Management Agency (FEMA) guidelines issued in 2015.

The HCMF Project (flood barrier) would provide for the design and construction of a permanent cast-in-place wall, at a height of 8.5 feet and a length of approximately 5,540 linear feet, and the installation of movable flood gates at the entrance to the HCMF.

The Right of Way Project (concrete sea wall), which takes into account revised FEMA guidelines issued in 2015, would provide for the removal of the temporary flood wall and construction of a permanent cantilever concrete sea wall supported on sheet piles. The permanent wall would be approximately 3,500 linear feet long, with a height varying from eight to ten feet, based on ground elevation.

## Solution

This project entails removing the existing flood wall system along the south and west perimeter of the Port Authority Trans-Hudson Corporation of the HCMF and replacing it with a permanent flood barrier protection system that would enhance the flood resiliency of the HCMF at a total estimated project cost of \$27.2



million for the flood barrier and \$32.3 million for the sea wall. The president of PATH entered into an agreement with the Town of Harrison to obtain the real estate required for this action.

## Project Facts

*Managing Agency:* Port Authority Trans-Hudson Corporation (PATH)

*Primary Federal Funder:* Federal Transit Administration

*Project Status:* In Construction

*Project Elevation (ft NAVD88):* 8.5 ft

*Environmental Documentation:*

*GIS Data:*

## Areas of Reduced Risk

- **Protect critical assets**
- **Maintain safe operations**
- **Enhance flood resiliency at the HCMF in the event of another major storm surge**

## References

1. Port Authority of Ny & NJ, Harrison Car Maintenance Facility Permanent Flood Barrier and Concrete Sea Wall Projects, Committee on Capital Planning ,Execution and Asset management November 17<sup>th</sup>, 2016
2. Port Authority Trans- Hudson Corporation Minutes Thursday, November 17<sup>th</sup> 2016





Gov. Andrew Cuomo's Office



SOM Projects Moynihan Train Hall

## Project Description

The Project will protect critical life safety and electrical equipment in the Penn-Moynihan Complex from catastrophic damage during heavy rains and from long-term damage during smaller, more frequent rain events. The Penn-Moynihan complex consists of the NEC section between the Hudson River Tunnel portals and the East River Tunnel Portals in Manhattan, existing PSNY and its associated tunnels, storage yards and support facilities, and the future Moynihan Station, to be housed in the Farley Building.

The Project will protect existing and planned critical facility electrical and life-safety equipment by reconstructing the entire north and south moats, install a waterproofing membrane, upgrade the drainage system, rehabilitate deteriorated steel, and reinforce and waterproof the existing concrete moat slab and sidewalk to protect existing and planned infrastructure investments for the long-term. The Penn-Moynihan complex is located between 7th and 9th Avenue, and 31st and 33rd Street in Manhattan, New York. The Farley Building is surrounded by a moat made up of several independent moats. Each area has walls and its own drain, and water does not flow from one moat to another. The Project work will focus on the north moat adjacent to the Farley Building located on 33rd Street between 8th and 9th Avenue, and the south moat adjacent to the Farley Building located on 31st Street between 8th and 9th Avenue.

## Solution

New York State and the Federal Government, along with the operation railroads and local stakeholders, are embarking on a much needed expansion of the facility through the redevelopment of the James A. Farley Building Post Office Building across 8th Avenue from the existing Penn Station New York (PSNY). Undertaken in two distinct phases, the Moynihan Station Program will adaptively re-use the former mail sorting facility and enable the relocation of Amtrak passenger-facing operations to a new, purpose-built intercity train hall as well as provide new amenities for Long Island Railroad (LIRR) commuters. The Moynihan Station Program is the first in a series of investments intended to expand concourse capacity, create Hudson River tunnel redundancy and add tracks and platforms to the Penn-Moynihan complex.





As part of these investments, a substantial upgrade of life safety systems is occurring. More specifically, this Project will install a state-of-the-art emergency smoke purge system underneath the Farley Building, which will be integrated with the existing system underneath the current facility east of 8th Avenue. These new systems, however, are below-grade and underneath a century old dry-moat structure that surrounds the Farley Building. The north moat will store the electrical substation and also will store the emergency back-up generator for Moynihan Station and the Farley Building. The electrical sub-station and switch gear rooms for the Penn-Moynihan train-shed catenary and signal systems are below the south moat. The moats' waterproofing and drainage system hasn't been upgraded in over 100 years, resulting in major degradation. Poor protection from water infiltration threatens the resiliency of the entire complex.

At the Penn-Moynihan Station, specific adaptation measures include:

- Removing the existing concrete sidewalk
- Removing protective slab over electrical vaults and train-shed electrical substation
- Removal of existing moat wall and moat slab
- Remediation and rehabilitation of moat structural steel
- Installation of new concrete moat slab and new moat walls consistent with historic preservation requirements
- Removal of existing moat windows
- Installation of state-of-the-art water-proofing membrane for moat and adjacent sidewalk
- Repair of facade along the moat perimeter
- Replacement of moat windows
- Protection of Amtrak train-shed switch gear

## Project Facts

*Managing Agency:* U.S Department of Transportation, Federal Railroad Administration (FRA)

*Statutory authority for grant/ cooperative agreement:* Disaster Relief Appropriations Act, 2013 (Public Law No. 113-2, January 29, 2013)

*Project Status:* The project is approximately 25% complete. The current schedule calls for partial opening of the Train Hall on June 30, 2020 and substantial completion on December 31, 2020. Full opening of the station will occur in early 2021.

## Areas of Reduced Risk

- **Facility electrical and life-safety equipment**
- **Rehabilitate deteriorated steel**
- **Protect existing and planned infrastructure investments for the long-term**

## References

1. U.S Department of Transportation Federal Railroad Administration Statement of work
2. Gov. Cuomo Inveils Renderings of New Penn Station – Moynihan Train Hall Complex  
<https://newyork.cbslocal.com/2016/09/27/new-penn-station-renderings/>
3. SOM Projects Moynihan Train Hall [https://www.som.com/projects/moynihan\\_train\\_hall](https://www.som.com/projects/moynihan_train_hall)





Source: USACE

## Project Description

In January 1995, the Corps of Engineers, State and City of New York completed the initial construction of the Coney Island shoreline protection project, the Coney Island Reach, which extends from West 37th Street to Brighton Beach.

The project area is located on the south shore of Long Island in the Borough of Brooklyn, Kings County, New York, and consists of approximately 3 miles of beachfront. The project provides storm damage protection to the densely populated urban communities and infrastructure located along the shoreline of Coney Island. Shore protection was provided by constructing a 100-foot wide beach berm at an elevation of 13 feet above sea level. The project included the construction of an 850-foot long terminal groin on the westernmost end of the project at West 37th Street. A fillet of sand was placed in the private community of Sea Gate to protect the groin against flanking and to prevent down drift conditions from deteriorating beyond those that existed before construction of the project.

Hurricane Sandy caused widespread damage to the project area. It caused millions of dollars' worth of damage to the businesses and neighborhoods in the area. This project will reduce future storm risk in the study area

## Solution

The initial construction of the Coney Island shoreline protection project (West 37th Street to Brighton Beach) was completed in January 1995. The total cost of the initial construction contract is cost shared at 65 percent Federal and 35% non-Fed. Due to the rapid rate of beach erosion down drift of the West 37th Street groin in the community of Sea Gate, approximately 600 tons of stone were placed adjacent to the West 37th Street groin in April 1996 to prevent a possible flanking condition. In June 1996, approximately 35,000 cubic yards of sand was placed adjacent to this groin to provide additional protection from potential flanking. In 2001, a stone revetment was constructed in this area to protect the groin and the west end of the project area from the continued threat of flanking caused by storm induced waves. A contract to remove accumulated sand along the Gravesend Bay area in the



community of Sea Gate was awarded in February 2004 to provide temporary relief to the area from wind blown sand while a long-term solution is developed.

A Reevaluation Report & Environmental Assessment was completed in January 2005, which recommended the construction of a series of T-groins to the west of the West 37th Street groin as a long-term solution to beach erosion and sand accumulation problems that have occurred in the Sea Gate area. A condition survey of the project area was completed in spring 2011. The plans & specifications for this section are nearing completion, and a new Project Partnership Agreement, necessary to initiate project construction, is currently being coordinated with the project sponsors, the State and City of New York. The Sea Gate portion of the project is considered to be an Authorized but Unconstructed project according to P.L 113-2 (The Disaster Relief Appropriations Act of 2013). Because of this, the Sea Gate portions of the project will be funded at 100% Federal cost. Project construction began in December 2014 and is scheduled and was completed June 2016.

## Project Facts

*Managing Agency:* USACE

*Primary Federal Funder:* USACE

*Primary Non-Federal Sponsor:* NYDEC

*Project Status:* Completed June 2016

*Elevation:* 13 feet above sea level

## Areas of Reduced Risk

- Coney Island
- Sea Gate

## References

1. USACE Rockaway Inlet to Norton Point (Coney Island) Fact Sheet <https://www.nan.usace.army.mil/Media/Fact-Sheets/Fact-Sheet-Article-View/Article/487599/fact-sheet-rockaway-inlet-to-norton-point-coney-island/>







Source: New York City

Source: New York City

## Project Description

Lower Manhattan, in particular the Lower East Side neighborhood, was heavily impacted by flooding caused by Hurricane Sandy's storm surge. Hurricane Sandy showed how vulnerable this area is to flooding during future hurricanes. In the face of climate change, rising sea levels, and increasingly frequent coastal storms, the City is taking steps to prepare for the future.

## Solution

The East Side Coastal Resiliency (ESCR) Project is the result of years of planning and cooperation among city, state, and federal agencies, culminating in a \$335 million federal grant from HUD's Rebuild by Design competition, which will fund design and construction. Additionally, \$3M of HUD Community Development Block Grant Disaster Recovery grant funds have been allocated to this project. The project includes the creation of a 2.4-mile flood protection system to protect the East Side of Manhattan from storm surge and sea level rise, from Montgomery Street to East 25th Street along the East River. The City will install a reliable flood protection system within City parkland and streets that will include a combination of floodwalls, an elevated and reinforced bulkhead with elevated esplanade, and deployable systems with drainage infrastructure. To offer the most comprehensive protection, the ESCR project will be engineered above the 2050 FEMA projection, at 16.50' NAVD88. Additional goals are to improve open spaces and enhance access to the waterfront, including at East River Park and Stuyvesant Cove Park. The City will provide an additional \$1.1B of City Capital Funds. When in place, the ESCR Project will provide improved coastal protection to more than 110,000 vulnerable New Yorkers as well as an enhanced waterfront, ecology, and urban spaces. Maintaining recreation opportunities is an important aspect of the project. Access points to these parklands will be built into the flood protection strategy and will consist of reconstruction of three pedestrian bridges to be universally accessible.



## Project Facts

*Managing Agency:* New York City

*Primary Federal Funder:* U.S. Department of Housing and Urban Development (HUD).

*Project Status:* The project is in concept design and construction is expected to begin in Spring 2020.

*Project Elevation (ft NAVD88):* 16.50' NAVD88

*Environmental Documentation:* EIS in progress

*GIS Data:* Shapefile of footprint

## Areas of Reduced Risk

- **Eastern section of the Lower East Side neighborhood in Manhattan.**

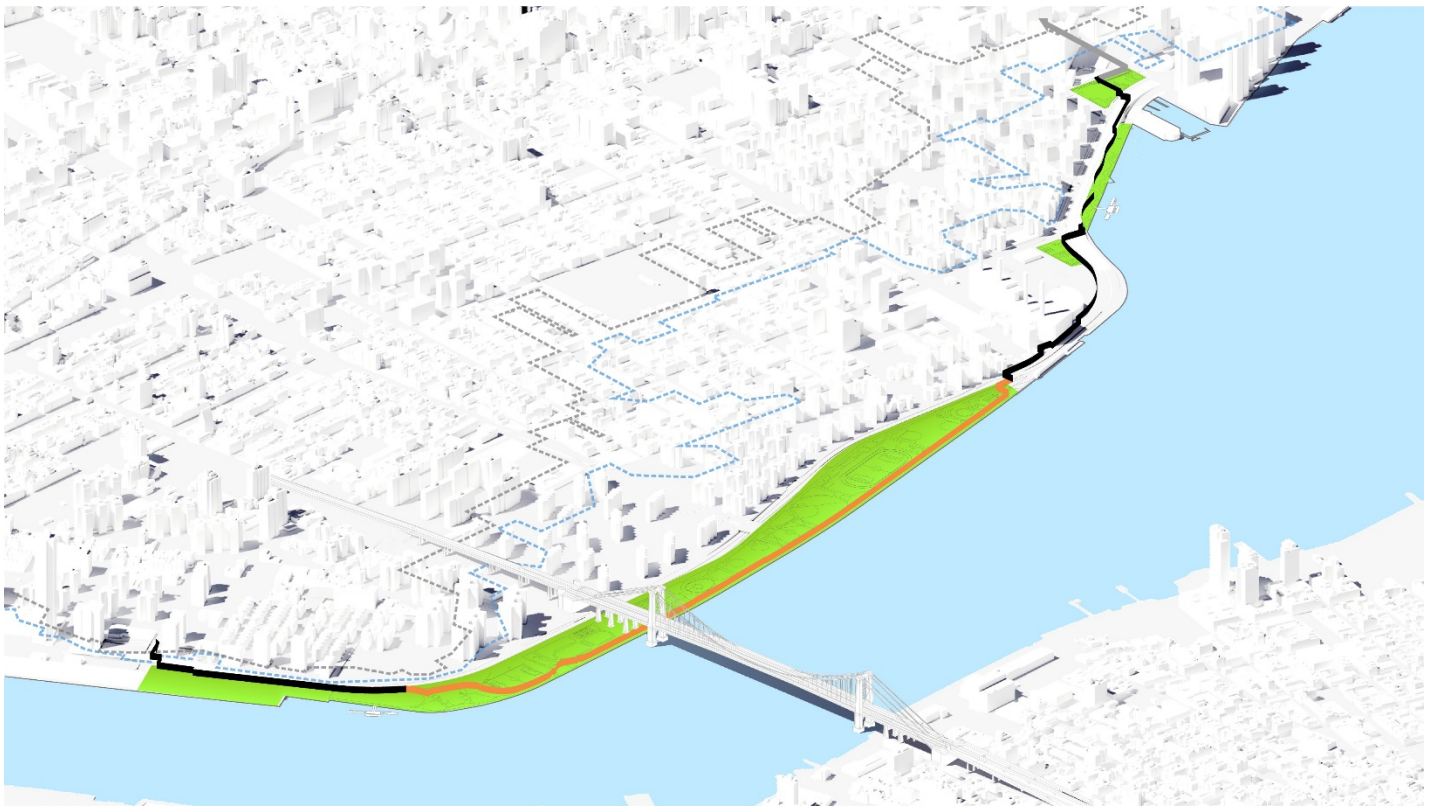


Figure 1. ESCR Flood Risk Reduction Measures.

## References

1. The East Side Coastal Resiliency Project/New York City. 2018. *The East Side Coastal Resiliency Project*. Accessed February 21, 2019. Available at <https://www1.nyc.gov/site/escr/index.page>.
2. The East Side Coastal Resiliency Project /New York City. 2018. *Progress – Meetings and Workshops*. Accessed February 21, 2019. Available at <https://www1.nyc.gov/site/escr/progress/meetings-workshops.page>.





Figure 2. Footprint of ESCR project. Image from The East Side Coastal Resiliency Project Preliminary Design Update Community Board 3 review, March 27, 2018.





Source: Google Maps

## Project Description

NJ's EPA Clean Water State Revolving Fund project, with financing agreements executed 6/28/16, for mitigation, including a new generator and upgrade of the electrical system, raising of existing equipment, sealing of buildings, and installation of flood protection devices, new flood protection wall, alarm system, and a co-generator system. As of May 2017, construction is 80% complete.

## Solution

### Project Facts

*Managing Agency:* NJDEP

*Primary Federal Funder:* EPA

*Project Status:*

*Elevation:*

### Areas of Reduced Risk

- **Middletown Township Sewer Authority**
- **Protect utilities for the surrounding area**
- **Protect the Sewage Pump station**



## References





## Project Description

The Cities of Hoboken and Jersey City, and the Township of Weehawken, are situated in low-lying areas along the Hudson River, and are therefore prone to flooding during storm events. In October 2012, they were inundated by Superstorm Sandy and remained flooded for several days, making it difficult for emergency response to reach residents. In 2013, The United States Department of Housing and Urban Development (HUD) initiated the Rebuild By Design (RBD) competition, asking firms to design plans to address the coastal and fluvial storms risks revealed by Superstorm Sandy. One of the solutions offered in this competition was for the City of Hoboken and the surrounding area.

The project is located in the City of Hoboken, as well as adjoining sections of Jersey City and Weehawken. This area is located below the steep cliffs known as the Palisades, along the shore of the Hudson River, and is home to 56,918 residents<sup>1</sup>.

## Solution

In order to protect the residents of the study area, a complex system of flood risk reduction measures has been proposed throughout the City of Hoboken, parts of Weehawken and Jersey City. This consists of an alignment (varying in height between 2 and 12.5 feet above grade), interspersed with deployable gates, around Weehawken Cove, and another North of Hoboken Terminal. Additionally, the City of Hoboken is pursuing the creation of three major stormwater detention sites will be created, along with 61 smaller tanks throughout Hoboken. Three new pump stations will be built as well, along with two new outfalls in Weehawken Cove. This solution decreases the coastal storm risk for approximately 85 percent of the residents within the 100-year floodplain of the study area.





## Project Facts

*Managing Agency:* State of New Jersey, Department of Environmental Protection

*Primary Federal Funder:* U.S. Department of Housing and Urban Development

*Project Status:* Planning and Design Phase

*Construction Agency and Status:* TBA

*Project Elevation (ft NAVD88):* 100-year flood + 2.34 feet

## Areas of Reduced Risk

- **Hoboken**
- **Jersey City**
- **Weehawken**



## References

1. New Jersey Department of Environmental Protection (NJ DEP) (2017). Final environmental impact statement, rebuild by design Hudson River: Resist, delay, store, discharge project. Available at <http://www.nj.gov/dep/floodresilience/rbd-hudsonriver-feis.htm>





Source: USACE

### Project Description

The U S Army Corps of Engineers (USACE) proposes a floodwall which would wrap around the south and east sides of the Oakwood Beach Wastewater Treatment Plant (WWTP). The floodwall would be built to an elevation of 19.4' NAVD88, or about a 300 year flood. The WWTP suffered a lot of damages due to Superstorm Sandy. The firm of Hagerty, consultants to the City of New York Department of Environmental Protection (NYCDEP), had been working on a hazard mitigation proposal to protect the plant from a 500 year (0.2%) flood (which, in this location along the east side of the plant, is 21'), in accordance with FEMA guidelines and regulations for the protection of a critical action facility. Flooding within the plant occurred primarily from two sources: overland flow from the Sandy surge, and a plant back-up (surcharge) of the process stream flow due to main outfall being below the level of the Sandy flood waters. In response to these flood pathways, Hagerty proposed a number of mitigation measures. The most important of these were a sheet pile flood wall about 4,200 feet in length around the entire facility, and an effluent pumping station which would discharge above the Design Flood Elevation (DFE), to be used in times of flood emergencies. The sheet pile wall would be driven 30 feet below grade and have an average height of 9 to 11 feet above grade.

### Solution

As noted above, the USACE floodwall is designed to mitigate a 300 year flood (the DFE, or 19.4' NAVD88). The WWTP has been classified as a Critical Action facility by FEMA, for public health and safety reasons. Because of this classification, if FEMA funds are to be used to provide flood protection for the plant, the DFE is defined as the 500 year flood (21' NAVD88) under requirements found in Executive Order 11988 and 44 CFR 9.6.



## Project Facts

*Managing Agency:* USACE

*Primary Federal Funder:* USACE, FEMA

*Primary Non-Federal Sponsor:* NYDEC

*Project Status:* Completed June 2016

*Elevation:* 19.4' NAVD88

## Areas of Reduced Risk

- **Oakwood Beach Wastewater Treatment Plant**
- **South Shore Staten Island**

## References

1. USACE South Shore of Staten Island Coastal Storm Risk Management Phase 1 Presentation Aug 2015





Source:

Source:

## Project Description

The Middlesex County Utilities Authority MCUA owns and operates the Sayreville Pump Station (SPS), which is a regional raw sewage pumping facility in Sayreville, NJ. The SPS pumps approximately 70-75 million gallons per day (MGD) of average daily dry weather sanitary flow from 32 municipalities in Middlesex, Somerset, and Union counties to its Central Treatment Plant. The purpose of this project was to reduce the impact that natural disasters like Hurricane Sandy could have on the facility in the future and to avoid the loss of wastewater services. With this project in place, the potential for untreated sewage discharges from the SPS as a result of equipment failures, power outages, and flooding was greatly reduced.

## Solution

This project that was primarily funded through a FEMA Public Assistance (PA) grant. Elements not eligible for FEMA PA funds were covered by MCUA financing by an \$87.9M loan from the NJ SAIL (Statewide Assistance Infrastructure Loan) Program, as well as EPA Clean Water State Revolving Funding. The project consisted of building a perimeter floodwall around the boundary of the SPS property, encompassing the entire 4.4 acre facility. The perimeter floodwall protects the SPS, including its restored equipment and systems, from any damage that would be caused by future flood events. The floodwall was built to protect the SPS at the 500-year level with one additional foot of freeboard for a total elevation of 21 feet NAVD88. The perimeter floodwall is made from a combination of poured concrete and sheet-piling with a 60" sluice gate, and multiple 48" to 132" knife gates in order for water inside the floodwall to escape. Additionally, a permanent standby generator resiliency system was installed to run the pumps that will dewater the facility in the event of a disaster, and prevent another uncontrollable power loss and resulting shutdown of the SPS. Construction is underway and completion is anticipated by the end of 2021.



## Project Facts

*Managing Agency:* NJ State

*Primary Federal Funder:* FEMA PA

*Project Status:* in construction, will be completed in 2021

*Project Elevation (ft NAVD88):* 21 ft NAVD88

*Environmental Documentation:* Environmental Assessment

## Areas of Reduced Risk

- **Sayreville Pump Station Facility (4.4 acres) in New Jersey**

## References

1. FEMA. 2015. *Final Environmental Assessment, Middlesex County Utilities Authority, Flood Mitigation and Permanent Restoration of the Sayreville Pump Station, Sayreville, Middlesex County, New Jersey*. Report Number 4086-DR-NJ-PW 5061.
2. Personal communication with Joe Cryan. July 6, 2018.





## Project Description

One of the winning proposals from HUD's Rebuild by Design competition. Funds will support the first phase of a flood protection project in the northern New Jersey Meadowlands, within the Boroughs of Little Ferry, Moonachie, Carlstadt, and Teterboro, and the Township of South Hackensack. Project will address the impacts of coastal and riverine (fluvial) flooding on the quality of the human environment in the area, including heavy rainfall events and intense coastal storm events. The approximate project area boundaries are: Hackensack River to the east; Paterson Plank Road and the southern boundary of Carlstadt to the south; State Route 17 to the west; and Interstate 80 and the northern boundary of the Borough of Little Ferry to the north. The Record of Decision (ROD) was released December 2018.

## Solution

### Project Facts

*Managing Agency:* New Jersey Department of Environmental Protection

*Primary Federal Funder:* U.S. Department of Housing and Urban Development

*Project Status:* Study complete, in detailed design

*Project Elevation (ft NAVD88):* +7 ft NAVD 88 (+3 ft of freeboard for critical facilities), pending design updates

### References

<https://www.nj.gov/dep/floodresilience/rbd-meadowlands.htm>





## *Existing Water Projects by Other Agencies*

Agency	State	Integrated Strategies Area	Proposal
<b>DOI/NFWF/Rutgers University</b>	NJ	Arthur Kill/Kill van Kull	A grant was issued to use green and grey infrastructure to strengthen Marshes Creek and the local community in Linden, New Jersey. The project will provide community protection while strengthening ecosystem resiliency from floods and run-off impacts.
<b>DOI/NFWF/NYCDPR</b>	NY	Harlem River, East River, Western Long Island Sound	A grant was issued to restore ecosystem function and habitat in Starlight Park on the Bronx River in NYC. The project will re-naturalize the shoreline, restore habitat function, and remove contaminated soil.
<b>DOI/NFWF/NYCDPR</b>	NY	Harlem River, East River, Western Long Island Sound	A grant was issued to improve Harlem River's water quality and resilience through stream daylighting of the Tibbetts Brook, a tributary to the Harlem River. The project will reduce over 88 million gallons of stormwater runoff and decrease sewer overflow events by 15% annually.
<b>DOI/NFWF/NYCDEP</b>	NY	Jamaica Bay	A grant was issued to develop a self-sustaining oyster population in Jamaica Bay, New York. The project will improve water quality and increase oyster larvae recruitment.
<b>DOI/NFWF/NYCDPR</b>	NY	Jamaica Bay	A grant was issued to restore Spring Creek Park's 11 acres of salt marsh and 16 acres of coastal upland in Queens, New York. The project will reduce flood impacts, capture run-off, and contribute recreational space
<b>DOI/NFWF/NYCDPR</b>	NY	Jamaica Bay	A grant was issued to restore Sunset Cove's five acres of wetland and seven acres of upland habitat in Queens, New York. The project will enhance water quality, provide shellfish habitat, and increase public recreation access.
<b>DOI/NFWF/Borough of Monmouth Beach</b>	NJ	Lower Bay	A grant was issued to construct a 6,400 foot coastal dune and restore 17 acres of marsh in Monmouth Beach, NJ. Both terrains provide critical wildlife habitat and community protection.
<b>DOI/NFWF/NYCDPR</b>	NY	Lower Bay	A grant was issued to strengthen Coney Island's resilience through installation of 14 green streets in NYC, New York. The project will mitigate flooding, filter over two million gallons of stormwater run-off, and serve as a model to other communities.

Agency	State	Integrated Strategies Area	Proposal
<b>DOI/NFWF/City of Hoboken</b>	NJ	Lower Hudson River	A grant was issued to incorporate natural and nature-based infrastructure into Block 12's redesign in Hoboken, New Jersey. The project will increase stormwater management, reduce sewer overflow, and increase open space acreage.
<b>DOI/NFWF/Rutgers University</b>	NJ	Lower Raritan River	A grant was issued to perform 54 municipality assessments and impervious cover reduction action plans for the Raritan River Basin in New Jersey. The project will create a municipality strategy guide with recommendations, and implement projects that capture over 68 million gallons of stormwater annually.
<b>DOI/NFWF/City of Newark</b>	NJ	Newark Bay, Passaic River, Hackensack River	A grant was issued to restore Newark Bay's wetlands in New Jersey. The 12-acre restoration will buffer against shoreline erosion, improve flood control, and remove invasive plants.
<b>DOI/NFWF/NJDEP Office of Natural Resource Restoration</b>	NJ	Upper Bay, Lower Hudson River	A grant was issued to create and improve Liberty State Park's 40 acres of salt marsh and 100 acres of upland habitat in Jersey City, New Jersey. The project will improve ecosystem resiliency and create a new publicly accessible area within the park.
<b>FEMA HMGP/NYSDEC</b>	NY	Capital District	The project, in the City of Troy, NY, is the repair, rehabilitation, and stabilization of a 7,750-foot seawall. The seawall also protects a Rensselaer County sanitary interceptor. The sea wall exhibits varying degrees of deterioration along its length and impact damage due to ice flows, high velocity flooding and impact damage due to debris traveling downstream.
<b>FEMA HMGP/Port Authority of New York and New Jersey (PANY&amp;NJ)</b>	NY	Harlem River, East River, Western Long Island Sound,	The proposed project at LaGuardia Airport is to construct a floodwall around the West Field Lighting Vault Building, which controls a significant portion of the runway and taxiway lighting systems. Another proposed project is to protect the West End Substation from flooding by installing dikes and re-grading. The West End Substation, although in an area that is higher in elevation than the rest of the airport, is susceptible to flood water damage. This substation supplies a large portion of the airport with electrical power, including pump stations, numerous buildings, and terminals.

Agency	State	Integrated Strategies Area	Proposal
<b>FEMA HMGP/NYSDEC/Town of Clarkston</b>	NY	Hudson Valley	The project, in Clarkstown, NY in Rockland County, is the elevation and extension of the Klein Avenue Levee. Increases in rainfall and storm severity have increased the flood elevation of the Hackensack River, reducing the effectiveness of the existing levee to protect the adjacent residential neighborhood, local businesses, and public Infrastructure from flooding in severe storm events. The project will raise and extend the levee to provide required freeboard above the base flood elevation to prevent overtopping and contain the Hackensack River to the river channel and overbank areas.
<b>FEMA HMGP/NYC</b>	NY	Jamaica Bay	The proposed Breezy Point, Queens risk mitigation project has two principal components: 1) a double dune system on the ocean side of the community and 2) new protective measures on the bay side. The new measures on the bay side entails widening of beach for urgent flood control and erosion protection. Protection will be further accomplished by creating a series of bayside flood and erosion protection devices, including an H-Pile baffle wall, T-head groins, PVC sheet pile and beach fill.
<b>FEMA HMGP/NYSDEC</b>	NY	Jamaica Bay	The project, in Spring Creek, Queens, NY was initially developed by USACE as an ecological restoration project, but is being revised to optimize flood and storm damage reduction. The project includes re-contouring the grade on site, creating a uniform elevation. The project will restore over 150 acres of valuable maritime habitats including 86.6 acres of upland buffer (dunes and maritime forest), 49 acres of low marsh, 10 acres of high marsh, and 6 acres of tidal creek. Collectively, the wetland and upland systems will reduce the impacts of future coastal storms by reducing wave energy and providing a barrier to flood waters.
<b>FEMA HMGP/NJDEP</b>	NJ	Lower Bay	The proposed project aims to assist private, residential property owners with the elevation of their flood damaged properties in the cities/towns/boroughs of Highlands, Keansburg, Little Silver, Rumson, Sea Bright, Union Beach, Long Branch, Middletown, Monmouth Beach, and other municipalities in Monmouth County, NJ.
<b>FEMA HMGP/NJDEP</b>	NJ	Lower Raritan River	The proposed project is to elevate flood prone private residential structures at or above the base flood elevation in Sayreville Borough, Middlesex County.



Agency	State	Integrated Strategies Area	Proposal
<b>FEMA HMGP/NJDEP</b>	NJ	Lower Raritan River	This State-administered acquisition program will strive to acquire and demolish properties in the flood-prone communities of Sayreville Borough (129 properties), South River Borough (76 properties), and Woodbridge Township (89 properties) in Middlesex County, NJ.
<b>FEMA HMGP/NJDEP</b>	NJ	Newark Bay, Passaic River, Hackensack River	The proposed project aims to assist private, residential property owners with the elevation of their flood damaged properties in the cities/towns/boroughs of Little Ferry, Moonachie, New Milford, Lyndhurst, and Hackensack in Bergen County, NJ
<b>FEMA HMGP/NYSDEC</b>	NY	Statewide (Capital District is listed as a focus area)	This project aims to upgrade and enhance resiliency of 104 scour-critical and flood prone bridges across the State of New York to ensure that they are fully protected to withstand future threats.
<b>FEMA PA/PVSC</b>	NJ	Newark Bay, Passaic River, Hackensack River	For the Passaic Valley Sewerage Commission, the proposed project is to construct a flood-protection system at the facility and fund a microgrid project, which will allow the plant to continue to operate when a larger power outage occurs. PVSC already has invested \$10 million of its own funds and more than \$72 million in FEMA Public Assistance funding to both repair damage and implement temporary mitigation measures including the installation of flood barriers and the elevation of key systems, while the comprehensive flood protection project, scheduled to be completed within 5 to 7 years, is built.
<b>HUD/Rebuild by Design</b>	NY	Harlem River, East River, Western Long Island Sound	The proposed project, <i>Hunts Point Lifelines, South Bronx, New York City</i> , includes an experimental flood protection levee to keep the peninsula dry while providing waterfront greenway for the everyday use of the community. The team also proposed new pier infrastructure that supports a federal plan to create marine highways and improve the East Coast's disaster preparedness.
<b>HUD/Rebuild by Design</b>	NY	Lower Bay	The proposed project, <i>Living Breakwaters, South Shore of Staten Island</i> , is a system of breakwaters that buffer against wave damage, flooding, and erosion and are also designed to sustain habitat. The pilot site is Tottenville, NY.

Agency	State	Integrated Strategies Area	Proposal
<b>HUD/Rebuild by Design</b>	NJ	Lower Hudson River	The proposed project, <i>Resist, Delay, Store, Discharge: A Comprehensive Strategy for Hoboken, NJ</i> , is a comprehensive urban water strategy that deploys programmed hard infrastructure and soft landscape for coastal defense (resist); policy recommendations, guidelines, and urban infrastructure to slow rainwater runoff (delay); a circuit of interconnected natural and nature-based infrastructure to store and direct excess rainwater (store); and water pumps and alternative routes to support drainage (discharge).
<b>HUD/Rebuild by Design</b>	NY	Lower Hudson River and Harlem River, East River, Western Long Island Sound	The proposed project, <i>The BIG U, Lower Manhattan, New York City</i> , is a protective system around Manhattan from West 57th Street south to The Battery and to East 42th Street. The Big U protects 10 continuous miles of low-lying geography using a proposed system of connected berms, deployable flood walls, and elevated path to manage coastal and stormwater flooding, while also providing social and environmental benefits to the community and an improved public realm.
<b>HUD/Rebuild by Design</b>	NJ	Newark Bay, Passaic River, Hackensack River	The proposed project, <i>New Meadowlands: Productive City + Regional Park</i> , is a large, natural, public reserve that offers flood protection. Around and across the Meadowlands, the project proposes an intricate system of berms and marshes to protect against storm surges, collect rainfall, and reduce sewer overflows in adjacent towns. Shifts in land-use zoning are also proposed for this project. Three pilot areas were identified: the northern edge includes sections of Little Ferry, Moonachie, Carlstadt, Teterboro, and South Hackensack; the eastern edge contains Secaucus and a portion of Jersey City; and the southern tip consists of South Kearny and the western waterfront of Jersey City.
<b>NOAA</b>	NJ	Lower Bay	In Sandy Hook, NJ, Hurricane Sandy caused extensive damage to the seawater system (part of the lab building) and building 74. The Site is part of the National Park Service (NPS) Gateway National Recreation Area. The state of NJ has leases with the NPS and leases the NPS Building 74 and NJ-owned lab. An annex site is proposed on former lab site.

Agency	State	Integrated Strategies Area	Proposal
<b>USDA/NRCS</b>	NY	Lower Bay	As part of the <i>New Creek/West Branch, Staten Island, NY</i> project, NRCS will provide \$7.5 million to restore this urban wetland. The project includes creating wetland pools that will reduce the speed of water flow and hold flood and storm water. Approximately 80 percent of streets in and around the project area regularly flood because they do not have storm sewers, and the improvements announced today will provide outlets for storm sewers to be constructed in the future. The restoration will provide habitat for animals and will promote native habitats that range from open water to upland forest.
<b>USDA/NRCS</b>	NY	Lower Bay	As part of the <i>Midland Beach and New Dorp, Staten Island, NY</i> project, the Emergency Watershed Protection - Floodplain Easement Program (EWP-FPE) acquires an easement in lieu of recovery measures is the more economical and prudent approach to reducing a threat to life or property. The easement area will be restored to the maximum extent practicable to its natural condition. Restoration utilizes structural and nonstructural practices to restore the flood storage and flow, erosion control, and improve the practical management of the easement.
<b>HUD</b>	NY	Lower Bay, Arthur Kill/Kill van Kull, Newark Bay, Passaic River, Hackensack River, Harlem River, East River, Western Long Island Sound, Lower Hudson River	Grantees will be required to identify unmet needs for housing, economic development and infrastructure and may use this allocation to address those unmet needs. Grantees will be required to incorporate a risk assessment in their planning efforts to ensure long term resilience.
<b>USDOT/NJ TRANSIT</b>	NJ	Lower Hudson River	New Jersey Transit Corporation (NJ TRANSIT) will receive funding to reduce the risk of flooding to Hoboken rail yard and the city by filling a deteriorated inlet inside the rail yard (Long Slip). This project would also improve disaster response and recovery by constructing new tracks and boarding areas on the filled area.



Agency	State	Integrated Strategies Area	Proposal
<b>USDOT/NJ TRANSIT</b>	NJ	Lower Raritan River	NJ TRANSIT will receive funding to replace the aged and deteriorated Raritan River Drawbridge that was damaged by Hurricane Sandy with a new bridge that is less vulnerable to storm surge and flooding.
<b>USDOT/NJ TRANSIT</b>	NJ	Statewide	NJ TRANSIT will receive funding to raise and protect vulnerable train signal, communication, and switch systems located within the 100-year flood zone for multiple rail lines.
<b>USDOT/Port Authority of New York &amp; New Jersey</b>	NY/NJ	Multiple states	The Port Authority of New York and New Jersey will receive funding to floodproof major above ground PATH facilities and equipment to prevent flooding of underground assets. These sites were flooded during Hurricane Sandy and are currently protected by temporary barriers.
<b>USDOT/Port Authority of New York &amp; New Jersey</b>	NY/NJ	Newark Bay, Passaic River, Hackensack River	The Port Authority of New York and New Jersey will receive funding to construct an automated flood barrier at the Harrison Car Maintenance Facility, the PATH system's only maintenance facility, which was significantly damaged by Hurricane Sandy. This site is currently protected by temporary barriers.
<b>USDOT/Port Authority of New York &amp; New Jersey</b>	NY/NJ	Newark Bay, Passaic River, Hackensack River	The Port Authority of New York and New Jersey will receive funding to construct a concrete seawall to protect PATH tracks near the Passaic River.
<b>USDOT/NYCDOT</b>	NJ	Upper Bay	The New York City Department of Transportation (NYCDOT) will receive funding to acquire new ferry vessels for the Staten Island Ferry that are capable of side boarding; upgrade ferry landings to accommodate such vessels; and flood proof existing terminals to improve response to disasters.
<b>USDOT/MTA</b>	NY	Multiple areas	The New York Metropolitan Transportation Authority (MTA) will receive funding to construct multiple forms of flood protections at four rail yards that are vulnerable to flooding.
<b>USDOT/MTA</b>	NY	Multiple areas	The New York Metropolitan Transportation Authority (MTA) will receive funding to make flood protections for substations throughout system, and acquire four mobile substations for use in emergency response.
<b>USDOT/MTA</b>	NY	Multiple areas	The New York Metropolitan Transportation Authority (MTA) will receive funding to reduce the risk of floodwaters entering and traversing underground infrastructure through sealing at vulnerable locations.

Agency	State	Integrated Strategies Area	Proposal
<b>USDOT/MTA</b>	NY	Harlem River, East River, Western Long Island Sound	The New York Metropolitan Transportation Authority (MTA) will receive funding to make flood protections for the Long Island Railroad Long Island City yard, which is located within the 100-year flood hazard area. This yard serves diesel and electric trains, adding to resilience.
<b>USDOT/MTA</b>	NY	Harlem River, East River, Western Long Island Sound	The New York Metropolitan Transportation Authority (MTA) will receive funding to make flood protections for three NYCT support facilities: The Tiffany Central Warehouse, Zerega Central Maintenance and Training, and Revenue Control Facility.
<b>USDOT/MTA</b>	NY	Multiple areas	The New York Metropolitan Transportation Authority (MTA) will receive funding to install flood protections at street-level openings (stairs, vents, etc.) at locations throughout the system that are between the 100- and 500-year flood hazard areas and beyond.
<b>USDOT/MTA</b>	NY	Harlem River, East River, Western Long Island Sound	The New York Metropolitan Transportation Authority (MTA) will receive funding to make flood protections for the Metro-North Railroad Hudson River Line and other facilities.
<b>USDOT/MTA</b>	NY	Multiple areas	The New York Metropolitan Transportation Authority (MTA) will receive funding for flood proofing of communications and signal rooms at 20 key subway stations within the flood hazard area.
<b>USDOT/MTA</b>	NY	Multiple areas	The New York Metropolitan Transportation Authority (MTA) will receive funding to upgrade pumping capacity by improving existing equipment, purchasing mobile equipment and creating two new pump trains.
<b>USDOT/MTA</b>	NY	Multiple areas	The New York Metropolitan Transportation Authority (MTA) will receive funding to make flood protections for critical underground equipment in flood risk areas throughout NYCT subway system, including circuit breaker houses, relay rooms, signal towers and pump rooms.
<b>USDOT/MTA</b>	NY	Multiple areas	The New York Metropolitan Transportation Authority (MTA) will receive funding to make flood protections at multiple tunnel portals used by the Long Island Railroad and Amtrak.
<b>USDOT/MTA</b>	NY	Multiple areas	The New York Metropolitan Transportation Authority (MTA) will receive funding to make flood protections for Rockaway Line stations, track and a police facility.

Agency	State	Integrated Strategies Area	Proposal
<b>USDOT/MTA</b>	NY	Multiple areas	The New York Metropolitan Transportation Authority (MTA) will receive funding for flood proofing at four bus depots within the 100-year flood hazard area.
<b>USDOT/MTA</b>	NY	Lower Hudson River	The Port Authority of New York and New Jersey will receive funding to make flood protections within the Penn-Moynihan Station Complex to protect existing transit facilities from damage during heavy rains.
<b>USDOT/MTA</b>	NY	Lower Hudson River	The Port Authority of New York and New Jersey will receive funding to make flood protections at the World Trade Center complex to protect underground transit assets and other infrastructure.
<b>USDOT/MTA</b>	NY	Lower Bay, Jamaica Bay, Upper Bay, Harlem River, East River, Western Long Island Sound, Lower Hudson River	MTA will use the funds from the US Department of Transportation to complete hundreds of projects in the following categories to repair transit functions: Rail Support and Equipment Facilities Repair: \$535 million for critical repairs primarily to three damaged under-river tunnels—Greenpoint, Montague, and Steinway; Electrical and Power Distribution Repair: \$138.9 million to restore damaged substations and power infrastructure for the Long Island Rail Road (LIRR) and Metro-North Railroad; Signal and Communication Repair: \$88.1 million to repair essential communications and signal equipment for Metro-North (system-wide) and LIRR's Long Beach Branch and Westside storage yard; Transitway Line Restoration: \$91.5 million to restore damaged rights of way on the Metro-North Harlem, Hudson, and New Haven Lines; and for design services to make long-term repairs to damaged assets; Rail Stations, Stops, and Terminals: \$32 million to repair to stations, employee facilities, and fare collection equipment for both rail and bus facilities.
<b>NOAA</b>	NY/NJ	Multiple states	This effort will contract topometric-bathymetric light detection and ranging (LiDAR) data collection of the shoreline in the highest impact areas from Hurricane Sandy (primarily NY/NJ).
<b>NOAA</b>	NY/NJ	Multiple states	This effort will contract topometric-bathymetric LiDAR data collection of the shoreline in the highest impact areas from Hurricane Sandy (primarily NY/NJ).



Agency	State	Integrated Strategies Area	Proposal
<b>NOAA</b>	NY/NJ/CT/RI	Multiple states	Activity 1: Install water level stations and collect water level and ellipsoidal data in NY, NJ, CT, and RI to refine datum models to support hydro and shoreline surveys from Rhode Island to New Jersey (CO-OPS). Activity 2: Establish global positioning system observations for determining geodetic to ellipsoid relationships at historic tidal gauge sites (NGS).
<b>HUD</b>	NJ	Statewide	Grantees will be required to identify unmet needs for housing, economic development and infrastructure and may use this allocation to address those unmet needs. Grantees will be required to incorporate a risk assessment in their planning efforts to ensure long term resilience.
<b>HUD</b>	NY	Statewide	Grantees will be required to identify unmet needs for housing, economic development and infrastructure and may use this allocation to address those unmet needs. Grantees will be required to incorporate a risk assessment in their planning efforts to ensure long term resilience.
<b>NJDEP</b>	NJ	Lower Bay	Union Beach Beachfill
<b>NJDEP</b>	NJ	Lower Bay	Sea Bright Seawall
<b>NJDEP</b>	NJ	Lower Raritan River	Bayshore Flood Gate Facility Management
<b>NJDEP</b>	NJ	Statewide	A grant to build ecological solutions to coastal community hazards was issued. The funding will be used to develop, design, and deliver natural and nature-based infrastructure techniques that add ecological value and enhance community resiliency. The project will benefit New Jersey coastal communities.
<b>NY Rising</b>	NY	Harlem River, East River, Western Long Island Sound, and Lower Hudson River	In Lower Manhattan, NY, the proposed projects are to evaluate cost and feasibility of various stormwater capture and retention approaches, wetland creation at East River Park, constructing berms and deployable floodwalls at Battery Park, develop flood protection strategies for Lower West Street (north and south of Battery Park City), and performing a feasibility study and conceptual design for multipurpose flood barriers using a raised greenway, berms, and deployable flood walls on the east and west sides of Lower Manhattan.

Agency	State	Integrated Strategies Area	Proposal
<b>NY Rising</b>	NY	Hudson Valley	In Stony Point, NY, the proposed projects are to repair, rehabilitate, upgrade, and fortify critical infrastructure (transportation, wastewater facilities, interceptors, and sewer lines), and to implement shoreline protection at Beach Road and River Road.
<b>NY Rising</b>	NY	Hudson Valley	In the Town and Village of New Paltz, NY, the proposed projects are to develop flood prevention strategies, implement stormwater management measures for the Wallkill River, investigate inflow and infiltration, repair collection systems, replace the Carmine Liberta bridge, rehabilitate Rt. 299 W and Springtown Road, and harden infrastructure in the sewage treatment plant.
<b>NY Rising</b>	NY	Hudson Valley	In the Town and Village of Saugerties, NY, the proposed projects are to repair, rehabilitate, upgrade, and fortify critical infrastructure (water supply, transportation, wastewater facilities, sewer lines, stormwater culverts at Platte Cove and Wilhelm Rd, bridge abutments), to repair supporting structures near the local lighthouse, and to implement stream bank and shoreline stabilization at Tina Chorvas Park. Additional assistance regarding dredging and private housing floodproofing was also recommended.
<b>NY Rising</b>	NY	Jamaica Bay	In Breezy Point, NY, the proposed projects are to enhance dune walkways, develop coastal protection projects in Breezy Point, Rockaway Point, and Roxbury, elevate Rockaway Point Boulevard, and improve stormwater drainage in Breezy Point and Roxbury.
<b>NY Rising</b>	NY	Jamaica Bay	In Broad Channel, NY, one of the proposed projects is to restore the Sunset Cove ecosystem and integrate it into a larger restoration project by the NYC DPR. Another project would be to construct a berm that would protect the Relief Campus as a first phase of a larger, comprehensive strategy and would extend between local high points on the NYC DPR and NPS property.
<b>NY Rising</b>	NY	Jamaica Bay	The proposed projects are to evaluate options for a storm surge reduction/flood barrier system in Gerritsen Beach, Sheepshead Bay, and Manhattan Beach, study and improve stormwater drainage infrastructure, and to repair and reconstruct bulkheads along Canton Court and Gerritsen Beach.

Agency	State	Integrated Strategies Area	Proposal
<b>NY Rising</b>	NY	Jamaica Bay	In Howard Beach, NY, the proposed projects are to evaluate the cost and feasibility of tide gates for the Shellbank and Hawtree Basins and a berm at Charles Memorial Park. Another project was the restoration of the Upper Spring Creek Ecosystem, which includes coastal protection features such as berms where flooding occurred in the Lindenwood neighborhood. Another project proposed protection strategies and drainage improvements along the northern edge of the Hawree Basin and Coleman Square, which would include a berm, coastal protection, and drainage improvements.
<b>NY Rising</b>	NY	Jamaica Bay	In Rockaway East, NY, the proposed projects are to use natural and nature-based infrastructure for stormwater collection and treatment in Thursby Basin Park, to restore wetland habitats and elevate portions of the Bayside Nature Trail along Avene, Edgemere, and Mott Basin.
<b>NY Rising</b>	NY	Jamaica Bay	In Rockaway West, NY, the proposed projects are to use bioswales for stormwater collection and treatment, and to target investment in coastal protection along Beach 88 <sup>th</sup> Street on the bayside of Rockaway West.
<b>NY Rising</b>	NY	Lower Bay, Jamaica Bay	In the East and South Shores Staten Island, NY, the proposed projects are to leverage existing coastal protection initiatives, including those by USACE, to comprehensively limit the exposure of the East and South Shores to storm surge. This includes implementing an interim East Shore coastal protection measure (planting and stabilizing temporary dunes) and to fill in the gaps of dunes between the NYC DPR dunes and the NPS dunes adjacent to Miller Field, construction of a dune system in Tottenville and Great Kills, and integrated South Shore Protection Plan, which builds upon the existing USACE feasibility study for the South Shore of Staten Island. A feasibility study for flood protection alternatives at Mill Creek is also proposed. Additional projects include installing BMPs to capture stormwater, alleviate flooding, and improve water quality in the Staten Island Bluebelt, along New Creek and Hylan Boulevard. Property acquisition and buyouts are another proposed project in South Beach.



Agency	State	Integrated Strategies Area	Proposal
<b>NY Rising</b>	NY	Upper Bay	In Brighton Beach, Coney Island, Manhattan Beach, and Sea Gate, NY, the proposed projects are to improve Mermaid Avenue to attenuate stormwater, replace the bulkhead on Sea Gate Association property and private residential properties, implement a flood barrier for Ocean Parkway and W. 25 <sup>th</sup> Street, evaluate potential storm surge protection for Manhattan Beach and Sheepshead Bay, improve water utility infrastructure along the boardwalk, and plant beach and dune grass in Brighton Beach and Coney Island.
<b>NY Rising</b>	NY	Jamaica Bay	In Red Hook, NY, the proposed projects are to perform a drainage study to determine existing flooding conditions, and to construct a comprehensive flood management system to protect Red Hook.
<b>NYC EDC/NYC ORR</b>	NY	Jamaica Bay	The second phase of proposed improvements for the Rockaway Beach Boardwalk Reconstruction project is the construction of a new, more resilient boardwalk that features various coastal protection structures such as a sand retaining wall, a dune “betterment” which will increase the overall height of the USACE dune, sand infill underneath the new boardwalk, dune plantings, and other sand retention measures. With elevated, steel-reinforced concrete and multiple layers of protection, including approximately six miles of retaining walls and planted dunes, the design is being rethought to make it sturdier and better able to withstand future hurricanes.
<b>NYC EDC/NYC ORR</b>	NY	Jamaica Bay and Lower Bay	The goal of the Raise Shorelines Citywide Study is to understand the extent of shorelines exposed to sea level rise, reinforce the shoreline to prevent erosion, and address risk of sea level rise by increasing the height of coastal edges. The first two areas to be assessed include the area of the bayside of the Rockaway Peninsula, and in Brooklyn, near Floyd Bennett Field, near the neighborhoods of Mill Basin, Bergen Beach, and other neighboring areas. A second area includes the southern shore of Staten island between Annadale to Tottenville.

Agency	State	Integrated Strategies Area	Proposal
<b>NYC EDC/NYC ORR</b>	NY	Lower Bay	The Coney Island Creek Tidal Barrier and Wetlands feasibility study is a critical component to resiliency planning for the communities around Coney Island Creek. This study would investigate hydrological management strategies that would prevent and mitigate upland flooding, improve waterfront open space, strengthen neighborhood connections, enhance infrastructure, and provide opportunity for economic development around the creek.
<b>NYC EDC/NYC ORR</b>	NY	Upper Bay	During Superstorm Sandy, the Gowanus Canal and Newtown Creek were major sources of flooding in the neighborhoods of Gowanus, Red Hook, Greenpoint, East Williamsburg, Bushwick, Maspeth, and Long Island City, causing substantial damage to infrastructure, homes, and businesses along both waterways and in neighboring upland areas. As recommended in the plan, the Gowanus Canal and Newtown Creek feasibility studies will further investigate how storm surge barriers could prevent flooding to nearby properties and infrastructure from future coastal storms.
<b>NYC EDC/NYC ORR</b>	NY	Upper Bay	For the Red Hook neighborhood of Brooklyn, NYCEDC and NYC ORR are initiating a feasibility study for an integrated flood protection system. Red Hook was severely impacted by Hurricane Sandy, and this study seeks to identify an integrated approach to address coastal flooding and storm water management that is also cognizant of, and fosters, feasible economic development opportunities. This project is expected to be funded through the Federal Emergency Management Agency's (FEMA) Hazard Mitigation Grant Program, administered by the New York State Division of Homeland Security and Emergency Services. Additional funding may be provided by the Community-Development Block Grant-Disaster Recovery (CDBG-DR) program, and is included in the City's CDBG-DR Action Plan. This project is discussed in the NYRCR plan.

Agency	State	Integrated Strategies Area	Proposal
<b>NJDEP/Rutgers University</b>	NJ	Arthur Kill/Kill van Kull	The study conducted by Rutgers University: a) determined the causes of flooding in the Cities of Elizabeth, Linden and Rahway, and Woodbridge Township; b) determined current measures and measures envisioned by officials; and c) offered recommendations to mitigate flood risks (Rutgers, 2014d). Individual assessments of each jurisdiction are provided. Some synergies exist between the jurisdictions may allow them to share the flood mitigation benefits of some of the proposed measures.
<b>NJDEP/Stevens Institute of Technology</b>	NJ	Lower Hudson River	Stevens Institute of Technology and the Davidson Laboratory performed an assessment of the flood pathways in Hudson County. It revealed that a majority of the inundation experienced along the Hudson River waterfront of Hudson County can be attributed to three main entry points – the Morris and Long Slip Canals, and Weehawken Cove. Constructing flood mitigation structures at these critical entrance points should eliminate the majority of storm surge related flooding experienced in Hudson County during Hurricane Sandy.
<b>NJDEP/Rutgers University</b>	NJ	Lower Hudson River, Newark Bay, Passaic River, Hackensack River	Rutgers identified regional and municipal flood risk reduction strategies for both the Hackensack River and the Hudson River waterfront including the municipalities of Hoboken and Jersey City. Regional strategies include sea walls and gates at open channels. Municipal strategies for both municipalities include surface storage of water during storm events, separation of combined sewer outfall pipes, and green infrastructure.
<b>NJDEP/New Jersey Institute of Technology</b>	NJ	Newark Bay, Passaic River, Hackensack River	The New Jersey Institute of Technology (NJIT) conducted an investigation of alternative measures for flood mitigation in the Hackensack/Moonachie/Little Ferry area (NJIT, 2014a). Specific study recommendations include structural flood protection alternatives, nonstructural mitigation alternatives, and maintenance, asset management and regulatory improvements such as tide gates, pumping stations, and regulatory, organizational and policy operational improvements. Strategies for addressing flood impacts specifically in Little Ferry and Moonachie were also considered. Flood mitigation strategies were discussed at two scales: municipal, and block and lot.